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Proceedings

Royal Physical Society of Edinburgh



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PROCEEDINGS
OF THE
ROYAL PHYSICAL SOCIETY.

SESSION CXVIII.

Wednesday, 19th December 1888.—Professor Sir WM. TURNER,
M.B., LL D., F.R.S., President, in the Chair.

The CHAIRMAN delivered the following address :

Having now completed my period of office as President of the Society, to which, through the great courtesy of the Fellows, I was elected three years ago, it becomes my duty, before I resign the Chair to my successor, to say a few words on the present position of the Society.

When I first became a Fellow, so far back as 1858, the Society, under the fostering care of several admirable naturalists then resident in Edinburgh, was discharging most useful work, both by the reading and publication of papers, and by the discussions on them. All of these have now gone over to the majority, and of them I would more particularly refer to Professor John Fleming, Dr T. Strethill Wright, Dr Andrew Murray, Dr James Macbain, Dr Spencer Cobbold, Mr Alexander Bryson, and Dr John Alexander Smith, the last named of whom did excellent service to the Society for a number of years as our Secretary. Since this now somewhat remote period, the Society has exhibited, as is not unfrequent with such bodies, fluctuations both in the number of its members and in the quantity and quality of

the scientific work which it discharged. The publication of its *Proceedings*, which commenced in the year 1854, went on continuously until April 1866, when they were interrupted for a season. This was undoubtedly a serious discouragement to the younger naturalists, who found in this Society and in its publications a vehicle for communicating their observations both to their fellow naturalists in the city, and to the scientific world generally. It was therefore thought by several members that the time had arrived when an effort should be made to revive the publication of the *Proceedings*, and to put fresh vigour into the work of the Society. No one felt this more strongly than the late Mr Robert Gray, and, from the date of his appointment as Secretary, the Society acquired a fresh life, and by continuing its work with great activity has promoted the progress of science amongst its Fellows. Since the year 1880 the *Proceedings* of the Society have again been published with regularity, and form several handsome, well-illustrated volumes.

To go no further back than the past session, I would state that eighteen papers were read, and a number of exhibits of various specimens were made, by the Fellows. The papers embodied a wide range of subjects. The anatomy of the Flatworms was discussed by Mr W. E. Hoyle, and the same naturalist gave an account of recent researches into the Siphonophoræ. Mr F. E. Beddard, in continuation of his researches into the minute structure of the ovary in Monotremes and Marsupials, gave an account of the Graafian Follicle in *Didelphys*. Mr George Brook communicated a paper on the British species of *Lepadogaster*, and he, along with Mr T. Scott, read an account of some rare or previously undescribed Crustacea in the sea area of the Clyde.

On ornithological subjects we had communications both from Mr John Swinburne and Mr Harold Raeburn, whilst geological or palaeographical questions were considered in as many as seven papers. Thus Dr Traquair described his observations on Carboniferous *Selachii*; the effects of the earthquake in the Riviera were discussed by Mr Hugh Miller; both Mr B. N. Peach and Mr J. Bennie described

their observations on Eurypterids; whilst Mr Kidston has given us the results of a part of his work on the Ferns of the Coal-measures, and on the fructification and affinities of *Archæopteris hibernica*. But the Society has also had the benefit of several papers on more general subjects: thus Mr J. Arthur Thomson gave an elaborate synthetic summary of the influence of the environment upon the organism; Mr G. J. Ramage contributed an account of his visit to Fernando Noronha; and Dr Woodhead described the fittings of the new pathological laboratory founded by the Royal College of Physicians. This brief narrative of the papers communicated to the Society is evidence of the activity of its members, and affords, I hope, a satisfactory indication that this vigorous life will be continued during the present and many succeeding sessions.

To keep up, however, our position amongst scientific societies, we should ever be on the look out for fresh recruits. We must strive to enlist under our flag the younger generation of those interested and engaged in scientific work. In this city, which for so long has been a great educational centre, and where a scientific spirit so strongly prevails, there ought to be no difficulty in procuring new members to fill up the vacancies in our ranks caused either by death or through the change of residence of members to other places.

Advances in science are made not only by the older and more highly trained experts who bring to bear on the consideration of the problems which engage their attention, mature experience, and long continued reflection, but also by the younger minds, fresher and perhaps more active in their working, and less under the control of prevailing theories and modes of thought. These can look at things from new points of view, and can adapt themselves more readily to those aspects of questions which are so frequently undergoing modification in connection with new observations and a wider range of knowledge. It is by the combination of both the experience of maturity and the activity of youth that real progress is to be made, and in its arrangement and conduct of business the Society must take care that both of

these elements are retained and made use of. As regards its membership, the Society is now in a very flourishing state. The Ordinary Fellows number 250, the Corresponding 17, and the Honorary Fellows 22, making a total of 289.

The Treasurer's report will have shown you that the funds of the Society are in a very satisfactory condition, much more so, indeed, than has been the case for several years previously. As is known to most of you, the Society, two or three years ago, was considerably in debt, but through the efforts of Dr Traquair during his Secretaryship, and of our Honorary Treasurer, Mr George Lisle, not only has this debt been cleared off, but the part of the *Proceedings* for 1886-87 has been paid for, the cost of removal of the library of the Society to the new premises has been defrayed, and the Society now possesses a substantial balance at its credit in the bank. We owe our thanks to the Secretary and the Treasurer for their exertions in this matter, and for placing the Society in so satisfactory a financial position. The Society has sustained a loss during the year, which I feel that I ought to refer to, in the resignation, by Mr W. E. Hoyle, of his post of Librarian. To the work of the library Mr Hoyle gave much thought and time. His extensive bibliographical knowledge was always at the service of the Society. He managed the exchanges with other societies, and the present condition of the library owes much to his faithful services.

In resigning this chair to my successor, Dr Traquair, I would congratulate the Society upon having secured as its President one who for so many years has so closely identified himself with its work, and who, during his recent tenure of office as Secretary, has contributed so much to its usefulness and prosperity.

I. *On the occurrence of Sowerby's Whale* (*Micropteron bidens*)
in the Firth of Forth. By Sir WM. TURNER, M.B., LL.D.,
F.R.S., Professor of Anatomy in the University of
Edinburgh.

(Read 19th December 1888.)

At the beginning of the present century Mr James Sowerby described by the name of *Physeter bidens*¹ a male cetacean, 16 feet long, which was stranded near Brodie House, Elginshire. The specific character of the animal was the possession of two teeth, one on each side of the lower jaw. Since that time this cetacean has been known as Sowerby's whale, and though for many years the generic name *Mesoplodon*, suggested by M. Paul Gervais, was given to it, the most recent writers prefer to employ the older generic term *Micropteron*, proposed by A. Wagner, and used by Eschricht and G. Cuvier.

No subsequent Scottish specimen was observed until I recognised in the Museum of Science and Art in this city a skull which I gave an account of in 1872 to the Royal Society of Edinburgh,² and which I thought had probably belonged to an animal captured in the Scottish seas. In 1882 I described³ an imperfect skeleton obtained through the Messrs Anderson from an animal stranded in the preceding year at North Mavine, in Shetland; and in 1885 another specimen, collected by the same gentlemen, and from almost the same locality, came into my possession, and formed the subject of another communication.⁴ A few specimens taken on the coasts of continental Europe and in Ireland have been described by other naturalists, but only one specimen has been recognised on the coast of England, viz., at the mouth of the Humber in September 1885, recorded by Messrs

¹ Sowerby's British Miscellany of New and Rare Animals, vol. i., 1806.

² On the occurrence of *Ziphius cavirostris* in the Shetland Seas, and a comparison of its skull with that of Sowerby's Whale (*Mesoplodon Sowerbyi*)—Trans. Roy. Soc., Edinburgh, vol. xxvi.

³ Proc. Roy. Soc., Edinburgh, January 30, 1882, and Jour. of Anat. and Phys., April 1882.

⁴ Jour. Anat. and Phys., October 1885.

Southwell and Clarke.¹ A specimen was also obtained in 1867 on Nantucket Island, Massachusetts, U.S.

In October 1888 the Rev. Robert J. Craig, the Manse of Dalgety, most courteously wrote to tell me that the Earl of Moray's under-gamekeeper, Mr Hugh Wilkie, had just found a bottle-nosed whale, 15 feet long, in Dalgety Bay, near Burntisland, on the north side of the Firth of Forth. Thinking that the specimen might be a young *Hyperoodon*, which not unfrequently enters the Forth at that season of the year, I did not ask the animal to be sent entire to the University, but only the head. On its arrival I found that it was the head of Sowerby's whale. I immediately instructed my assistant, Mr James Simpson, to go to Dalgety and secure the rest of the carcass. Unfortunately, when he arrived there, the blubber had been removed, but he procured the skeleton and viscera.

The following table records the specimens which up to this time have been described :—

TABLE I.

Sex.	Locality.	Date.	By whom described.	Where preserved.
1. M.	Brodie House, Elgin.	1800.	J. Sowerby.	Oxford.
2. F.	Havre.	Sep. 1825.	{ De Blainville } and Cuvier.	Paris.
3. M.	Sallenelles, Calvados.	{ Summer 1825.	{ Deslongchamps.	Caen.
4. F.	Ostend.	Aug. 1835.	{ Dumortier and Van Beneden.	Brussels.
5. M.	{ Brandon Bay, Ire- land.	Mar. 1864.	W. Andrews.	Dublin.
6. ...	Norway.	1866.	Van Beneden.	Christiania.
7. ...	{ Nantucket Island, Mass., U.S.	1867.	Agassiz & Allen.	Harvard, U.S.
8. M.	Skager Rack.	June 1869.	A. W. Malm.	Göteborg.
9. M.	Brandon Bay.	May 1870.	W. Andrews.	Dublin.
10. F.	Scotland ?	1872.	W. Turner.	{ Mus. Science and Art, Edinburgh.
11. F.	{ Herringholm Strand, Jutland. }	Feb. 1880.	Reinhardt.	.....
12. M.	Vanholmen, Sweden.	Oct. 1881.	A. H. Malm.	Göteborg.
13. M.	Shetland.	Apr. 1881.	W. Turner.	{ Univ. Museum, Edinburgh.
14. M.	Shetland.	May 1885.	W. Turner.	{ Univ. Museum, Edinburgh.
15. M.	{ Saltö, Bohuslan, Sweden. }	Aug. 1885.	{ C. W. S. Auri- villius.	Stockholm.
16. M.?	Humber.	Sep. 1885.	{ Southwell and Clarke.	.....
17. M.	Firth of Forth.	Oct. 1888.	W. Turner.	{ Univ. Museum, Edinburgh.

¹ Annals and Mag. Nat. Hist., January 1886.

In addition to the above well-authenticated specimens, M. Van Beneden states¹ that he has seen a very incomplete cranium in the Museum at St Petersburg, but as to the origin of which nothing was known.

Specimens of Ziphioid whales from the Southern Hemisphere belonging to the genus *Micropteron* (*Mesoplodon*) have also been described, both by the New Zealand naturalists, by the late Dr Gray, and by Professor Flower.² Various specific names have been given to them. *Mesoplodon layardi* is undoubtedly a distinct species,³ but doubts have been expressed whether some, if not all, of those specimens to which the specific names *australis*, *grayi*, *haasti*, and *hectori* have been given, should be regarded as distinct species, or only varieties of *Micropteron bidens*. Quite recently Mr Fredk. W. True has described the cranium of a young *Micropteron* (*Mesoplodon*) collected by Dr L. Stejneger in Bering Island, in the Bering Sea, as a distinct species by the name of *Mesoplodon stejnegeri*.⁴ As the skull, however, is that of a young animal, its specific characters would be incompletely marked, and it is possible that this also may be *Micropteron bidens*.

Sowerby's whale is obviously not so rare a species as was at one time supposed. Table I. shows that seventeen well-authenticated specimens have been taken during the present century in the North Atlantic or its inlets, and of these sixteen have been got on the coasts of Europe. No fewer than seven specimens have been taken during the present decennium, three of which it has been my good fortune to obtain. As a knowledge of the Cetacea becomes more widely extended, we may expect to have what are usually regarded as the rarer species more frequently recognised, and the term "bottle-nosed whale," under which in common speech so many species are classed, more closely restricted to the species to which it properly belongs, *Hyperoodon rostratus*.

¹ Les Ziphioides des Mers d'Europe, Memoires couronnés publiés par l' Acad. Roy. de Belgique, t. xli., 1888.

² On the genus *Mesoplodon*, Trans. Zool. Soc., vol. x.

³ See my Report on Bones of Cetacea in "Challenger" Reports, vol. i., 1880.

⁴ Proceedings of the United States National Museum, 1885.

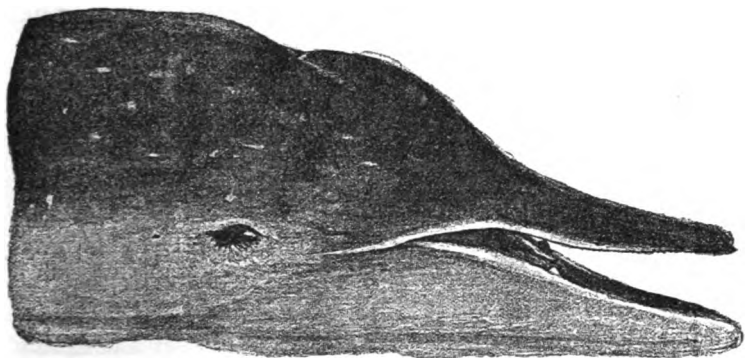
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1. The first step in the process of the investigation is the identification of the problem. This is done by the investigator who is responsible for the study. The investigator must first identify the problem and then determine the scope of the study. The next step is to design the study. This involves determining the methods to be used and the data to be collected. The third step is to collect the data. This is done by the investigator who is responsible for the study. The fourth step is to analyze the data. This involves determining the results of the study and the conclusions to be drawn. The final step is to report the results. This is done by the investigator who is responsible for the study.

Figure 1. The effect of the number of trials on the mean accuracy of the responses. The error bars represent the standard error of the mean.

the concavity forwards. It was not quite symmetrical, the right half of the crescent being a little anterior to the left, and more sharply curved forwards. Immediately behind the blowhole, the contour of the head was elevated above the plane of the blowhole for 2 inches, and then passed almost horizontally backwards.



Profile of head of Sowerby's whale, from a photograph by my son, Arthur Logan Turner. The black spot a little behind the eye is the auditory meatus.

Immediately in front of the blowhole the beak was raised as a convex eminence, which, when looked at from above was seen to be not quite symmetrical, but projected more to the right side of the mesial plane than to the left. In front of this eminence the beak sloped downwards and forwards with a gentle curve almost as far as the plane of the two mandibular teeth, beyond which it extended nearly in a straight line to the tip of the upper jaw. The side of the upper lip was slightly indented by the mandibular tooth, and the distance from this indentation to the tip of the beak was $9\frac{1}{2}$ inches. In front of the mandibular tooth, the upper border of the mandible was almost straight, as was also the mouth slit, but behind it both the mouth slit and the mandible were curved with the convexity upwards. From the angle of the mouth a furrow in the integument passed backwards, in line with the angle, for 5 inches on the surface of the head. It was at first deep, but gradually became shallower until it

was lost on the surface. The eye was placed behind the angle of the mouth, and immediately behind it the integument was depressed and corrugated. Behind the plane of the eye slit was the aperture of the external auditory meatus, which admitted only a fine bristle.

Only two mandibular teeth were seen. They projected only $\frac{3}{8}$ ths of an inch beyond the gum, and very slightly from between the lips when the mouth was closed. This small amount of projection, as compared with what is shown in Mr Andrews' figure of the head of his specimen, gave me the impression that my animal had not reached its complete adult development. The vertebral epiphysial plates were, however, for the most part ossified to the bodies.

The upper border of the mandible in front of each tooth was grooved for about 4 inches. No rudimentary teeth projected through the gum, neither were any found buried in its substance either in the upper or lower jaw. In this respect the animal differed from that examined by Reinhardt, in which three if not four small functionless teeth were present on each side of the upper jaw.

A pair of characteristic furrows was present in the sub-mandibular region. About 10 inches behind the tip of the lower jaw they were almost continuous with each other anteriorly, the interval between them being barely $\frac{1}{2}$ inch. From this spot they diverged as they passed backwards, so that their posterior ends, which were in the same transverse plane as the middle of the palpebral fissure, were 9 inches asunder. Each sub-mandibular furrow was not more than $\frac{1}{2}$ inch deep, and could be opened out at its widest to $\frac{1}{2}$ inch. The skin lining it was soft, and partially wrinkled. The wrinkling of the skin and the readiness with which the furrows could be dilated indicated that they could be both widened out and closed, a variation in their condition which is possibly associated with the state of the mouth when either full of food or empty. Mr Andrews, in his figure of the sub-mandibular furrow, makes the two limbs meet anteriorly, but in my specimen the relation between them corresponded with the appearance figured by Carl Annandale in the young male which he examined in

which their anterior ends were separated by a slight interval.

Colour of Skin.—The skin of the top and sides of the head was glossy, and of a dark bluish-grey or dark bluish-slate colour. It was mottled with numerous dark grey spots, some of which were almost circular in form, others more irregular, and which varied in their diameter from $\frac{1}{4}$ inch to about 1 inch. The centre of each of these spots possessed an almost white line or point. Between the diverging furrows in the sub-mandibular region, the colour was a light grey, approaching white, whilst behind these furrows the tint was a much darker grey. The margin of both the upper and lower lips was mottled with dark grey, and from the lower lip to the sub-mandibular region, grey was the prevailing tint, though it varied in depth on different parts of the surface. A faint wrinkling of the surface of the skin immediately behind and to the side of the blowhole was recognised, which was apparently due to a partial peeling off of the most superficial layer of the cuticle, for the skin was not wrinkled where the cuticle was still intact.

As I did not have the opportunity of observing the skin of the body behind the head, I requested the Reverend Robert J. Craig to note down the colour as he had seen it, and he has written to me that whilst the skin of the back was of a bluish slate-colour, the belly was a light slate-colour; that a number of whitish spots were scattered over the body but principally on the sides, and in some places these spots were connected by narrow streaks.

Although Sowerby, in his description, speaks of his male specimen as black above, nearly white below, yet his original coloured figure has almost caught the tints which I saw on the head, and which the Reverend Mr Craig recognised on the body generally. M. Dumortier's coloured figure of a female stranded at Ostend in 1836, represents the animal with a much lighter shade of blue, and in his description of the specimen, he says that in the living state the entire body "est du couleur brunâtre plombée, à l'exception du ventre, qui est blanchâtre et cendré." Dr A. H. Malm describes the male specimen found dead in 1881 off Vanholmen, Sweden, the

skeleton of which is in the Göteborg Museum, as of a dark slate-colour, with greyish white, irregularly scattered spots, especially on the ventral aspect. Mr Thomas Anderson, who saw the carcase of the Shetland specimen described by me in 1881, stated that the back was dark bluish-grey or slate-coloured, becoming lighter on the sides and whitish on the belly, and that grey or whitish streaks and spots, often circular, were irregularly scattered over the sides. Carl Auri-villius, in his account¹ of the young male caught in August 1885 (3870 mm., 12½ feet long), says that the skin on the back and sides was black-blue passing into lead-colour, and below it was bluish-grey but not whitish. Further, he states that its colour corresponded more with Sowerby's figure than with those of Dumortier and F. Cuvier. The animal, probably a male, captured at the mouth of the Humber in 1885, was reported to Messrs Southwell and Clarke² as being "very dark slate-colour, or nearly black on the top of the head and along the back, the sides a lighter shade of slate-colour and the under part much lighter still, but not quite white; the end of the beak and lower jaw rather lighter in colour than the upper portion of the head." There can, I think therefore, be no doubt, from the concurrent testimony of several observers, that this animal is not of the deep black colour on the dorsum which one sees in *Hyperoodon*, but that the dark hue is dashed with a bluish tint, so that one may describe the prevailing colour of the back as dark bluish-grey or bluish-slate colour. The grey or whitish, almost circular spots which were noticed by Mr Thomas Anderson in one of the Shetland specimens, and by myself in this animal caught in the Forth, are obviously also characteristic markings on the skin. The belly is not white but of various shades of grey, dashed perhaps with a bluish tint. The tail and pectoral limbs were similar in colour and shape to those in the specimen described by me in 1885, so that I need not repeat their characters on this occasion. As the dorsal fin had been cut away in that specimen, I did not see it; but in the present animal this fin was preserved and

¹ K. Svenska Vet.-Akad. Handlingar, Band 11, No. 10. October 1885.

² Annals and Mag. of Nat. Hist., January 1886.

had a well-marked falciform shape, with the concave border directed backwards. The skin of this fin was darker in colour than the surface of the back, and was more nearly black. The shape of the dorsal fin is not correctly given in Sowerby's drawing, but is properly represented in Dumortier's figure. In both of these drawings the tail is incorrectly figured as having a notch in the middle of its posterior border, whereas, as I have shown in the drawing of the tail in the specimen which I described in 1885,¹ this border was convex at its middle, so that the entire border had a festooned edge. The figure which Aurivillius has given of the tail in his animal closely corresponds with my original figure, and with the form of the tail observed in this most recent specimen. Reinhardt's figure of the tail of this animal,² though without the mesial notch, does not give a mesial convexity, and is not therefore quite accurate.

[NOTE.—*April* 1889.—Whilst correcting these sheets for the press, I received a copy of the *Evening Star* newspaper, published at Washington, U.S., April 3d, in which the capture of a female Sowerby's whale, 12½ feet long, at Atlantic City, New Jersey, on the 28th March, is recorded. The specimen was secured by Professor F. W. True for the National Museum, Washington. It is the eighteenth specimen which has been captured in the North Atlantic, and the eighth obtained during the present decennium.

I may also state that in the *Journal of Anatomy and Physiology*, April 1889, vol. xxiii., I have described the stomach of the specimen of Sowerby's whale from Dalgety Bay, and have compared it with the stomach of *Hyperoodon* and several of the Delphinidæ.]

¹ *Journal of Anatomy and Physiology*, October. Plate iv., vol. xx.

² Oversigt over d. K. D. Vidensk. Selsk. Forhdl., Copenhagen 1880.

II. *Notes on the White-beaked Dolphin* (*Delphinus (Lagenorhynchus) albirostris*). By Professor Sir WM. TURNER, M.B., LL.D., F.R.S.

(Read 19th December 1888.)

The white-beaked dolphin, although it has for a number of years been known to frequent the east coast of England,¹ has only recently been recognised as a denizen of the Scottish waters. When the late Mr E. R. Alston published his "*Fauna of Scotland*"² in 1880, its occurrence on the coast of Scotland had not apparently been recorded.

In September 1879, whilst Mr J. Y. Buchanan was returning from the closing cruise of the Northern Yacht Club, he shot in Kilbrennan Sound, Firth of Clyde, a cetacean which formed one of a school that came into close proximity with his yacht.³ The animal, he wrote to me, was 7 feet 9 inches long, 5 feet in greatest girth, and weighed 318 lbs. The colour was white on the belly, and blackish-grey on the back, whilst the fins and tail were leathery black. In the month of December Mr Buchanan kindly forwarded the skull to me, and from a comparison made shortly afterwards with crania in the Museum of the Royal College of Surgeons of England, it was obvious that the animal was an adult white-beaked dolphin. This specimen was therefore, I believe, the first of the species to be recognised in Scottish waters.⁴ In September 1880 a young male was captured near the Bell Rock, off the mouth of the Tay, and was presented to the Kelvingrove Museum, Glasgow. It was described shortly afterwards by Mr J. M. Campbell,⁵ and is the first Scottish

¹ Specimens have been described by Messrs Brightwell, J. E. Gray, Murie, D. J. Cunningham, J. W. Clark, and T. Southwell.

² Glasgow, January 1880.

³ I may state, that whilst yachting in August 1887 at the entrance to Kilbrennan Sound, my yacht steamed through a school of dolphins, which I believed to be the white-beaked dolphin.

⁴ This animal is No. 19 in the list of specimens of this cetacean captured in British waters, drawn up by Mr Thos. Southwell. (Trans. Norfolk and Norwich Naturalists' Soc., vol. iv., 1885.)

⁵ Natural History Society of Glasgow, November 30, 1880, and *Scottish Naturalist*, January 1881. The stomach and some other viscera of this specimen are described by Professor Cleland in the *Journal of Anatomy and Physiology*, vol. xviii., 1884.

specimen an account of which has been published. Since that time several additional specimens taken on or off the coast of Scotland have come into my possession, and are now in the Anatomical Museum of the University of Edinburgh. In 1881 I obtained from Mr Brotherston of Kelso the skull of another adult, which had been caught off Berwick in July of that year;¹ and in 1883 the same naturalist forwarded to me the skull of a young female, caught off Berwick in the month of August, the skin of which he had stuffed for the museum of that town. In 1885 the Rev. Dr Joass presented to me, for the University Museum, the skull of an adult female, taken so far north as the coast of Sutherland. Dr Joass writes to me that the animal was found beached on the sands of Kintradwell, seven miles east from Golspie, in May 1882. It contained a calf.

In July 1888 I purchased from one of the Edinburgh fish-mongers an adult female and a young male, which had been taken together off Stonehaven, Kincardineshire. The female was evidently the mother of the younger specimen, which was a suckling, for milk could easily be pressed out of her nipples. The relative size of the two can be seen from the following table of measurements:—

DIMENSIONS OF *Delphinus albirostris*.

	Adult.		Young.	
	ft.	in.	ft.	in.
Extreme length in a straight line,	8	6	3	11
Circumference of body in front of dorsal fin,	5	4	2	2
Width across tail,	2	1½	0	9
From mesial notch of tail to anus,	2	3	1	0½
Length of anterior border of flipper,	1	7	0	11
From root of flipper to angle of mouth,	1	3	0	5
Length of mouth slit,	0	9½	0	5½
From angle of mouth to eye,	0	2½	0	1½
Height of dorsal fin,	1	1	0	6
From blow-hole to tip of beak,	1	1	0	7½
From tip of beak to anterior edge of dorsal fin,	3	5½	1	10½
Transverse diameter of blow-hole,	0	1½	0	1
Eye to auditory meatus, . . . . .	...		0	1½
From penis to umbilicus, . . . . .	...		0	5½

¹ See "Land and Water," 16th July 1881, where it is incorrectly named *Delphinus turris*.

The following points were noted in the colour of the skin:—In the adult female the top of the head and the back, as far back as the dorsal fin, were black. Behind the dorsal fin the keeled lumbo-caudal ridge of the back was greyish-white, lighter indeed in tint than the side of the body immediately below it, but not so light as the belly. The belly generally was white, mottled with grey, but between the pectoral limbs and in the submandibular region it was almost pure white. The sides of the body were a dark grey, approaching to black, about the middle of its length, but becoming less dark towards the sides of the lumbo-caudal region. Both surfaces of the caudal fin were black, though with a greyish patch on the ventral keel. The dorsal fin was black. The pectoral limb was black on both surfaces, but with a slight greyish patch near the root of the anterior border. The head behind and immediately below the eye was a dark grey. The skin covering the mandible was whitish-grey, but almost white at the angle of the mouth. The skin of the tip of the beak, and that covering the sides of the upper jaw, was white, though with a grey tint, and with a darker patch at the middle of the tip of the beak. A distinct groove, $2\frac{1}{4}$ inches behind the tip, differentiated the anterior end of the beak. It extended backwards for some distance so as to mark off distinctly an upper lip from the side of the face. The white grey-tinted patch was not limited to the beak in front of this groove, but extended for about an inch behind and above it. The outline of the head ascended in a gentle slope backwards to the blow-hole. The mouth slit ran backwards almost in a straight line. The falciform dorsal fin ascended from almost the middle of the back, though its anterior border was much nearer to the tip of the beak than to the mesial notch in the tail.

The young male in its general scheme of colour approximated to the adult female, but with certain differences. The back for some distance behind the blow-hole was yellowish-grey on each side of the middle line, but in the middle line a dark brown patch extended forwards almost to the blow-hole. The belly was almost pure white, with scarcely any grey intermixed. The sides of the body were light-grey,

dashed with a yellowish shade. The dorsal fin was black. The tail was black on the dorsal surface, and dark grey on the ventral, but the ventral keel was almost white. The pectoral limb was black on both surfaces, and had no grey patch on its anterior border. The tip and the sides of the beak were differentiated by a distinct groove, and possessed a characteristic white appearance, dashed with yellow, which extended for a short distance beyond the groove on to the adjacent part of the face. At the tip, and on its right side, an elongated dark-grey patch about half an inch long was seen. In the white part of the left upper lip four black hairs, each about a half inch long, protruded out of distinct follicles which opened on the surface with small orifices. The most anterior of these hairs was $1\frac{1}{4}$ inches from the middle line of the tip of the beak, and the hair follicles were about $\frac{1}{16}$ ths of an inch asunder, and nearly 1 inch from the cleft of the mouth. An almost similar arrangement was present in the right upper lip, but only three hairs protruded close together, the fourth apparently not being developed. The blow-hole was semilunar, with its concavity directed forwards.



Head of a young male *Delphinus albirostris*, to show the moustache. From a photograph by David Wallace, M.B.

The presence of a rudimentary moustache in the young male white-beaked dolphin is interesting, as furnishing an interesting example of a cetacean in which the hairy coat characteristic of the mammalia generally, has not entirely disappeared. This is not the first occasion on which hairs have been seen in the white upper lip of this species. J. G. Gray described¹ six bristles, and both D. J. Cunningham² and J. W. Clark³ have recorded the presence of four bristles in each upper lip of their specimens.

Mr Clark's example was, like mine, a young male, Dr Cunningham's a young female, so that the rudimentary moustache is not a characteristic of the male sex. In the adult female which I examined, and in the adult specimens which have been observed by other naturalists, hairs in the upper lip were not seen, so that their presence is a mark of immaturity in this cetacean, in which they disappear as it attains adult life.⁴

The length of the adult female, 8 feet 6 inches (2593 mm.), establishes it as probably the longest adult female which has yet been measured. Brightwell's adult female was 2490 mm., and Van Beneden's was 2330 mm. But several adult males have been measured which exceeded it in length, as appears from the following table extracted from Max Weber's article⁵ on this dolphin:—

	Males. Metres.
Moore,	2.70
Max Weber,	2.74
A. W. Malm,	2.82
Claudius,	2.91
Claudius,	2.99

¹ Voyage of *Erebus* and *Terror*, p. 35, 1846.

² Proc. Zool. Soc., June 20, 1876.

³ *Ibid.*

⁴ In the *Megaptera longimana*, the anatomy of which has been so elaborately described by Professor Struthers, the stiff hairs in the lower lip varied from $\frac{3}{4}$ to 1 inch in length. The animal was 40 feet long, and the vertebral epiphyses were unossified (Jour. of Anat. and Phys., vol. xxii., pp. 119, 443). Various naturalists have described a moustache in the fœtus of the following genera of Delphinidæ, viz., *Delphinus*, *Tursiops*, *Steno*, *Lagenorhynchus*, *Globicephalus*, *Phocæna*; and Eschricht has described a moustache in the fœtus of *Balænoptera rostrata* and *Megaptera longimana*. (See M. Fischer in *Mélanges Cétologiques—Actes de la Soc. Linnéenne de Bordeaux*. Nov. 1868.)

⁵ Tijdschrift der Nederlandsche Dierkundige Vereeniging, Leiden, 1887.

As regards the colour of the skin, my two specimens show that differences occur at different ages. This probably accounts for the discrepancies in the descriptions of the colour markings as given by several writers. Sex also may influence the colour, though probably not to the same extent as age. In the young male the tip of the beak was more uniformly white, though with a dash of yellow, than in the adult female, in which it had a whitish-grey tint. In both, however, a darker grey patch was present at the exact tip.

Some light can now, I think, be thrown on the time of the year when this dolphin produces its young. The adult female obtained by Dr Joass was in calf in the month of May. The adult female, which I purchased in July 1888, was nursing the young male caught along with her. This whale produces her young, therefore, in the summer, probably in the months of June and July. My young specimen is smaller than the young female captured in September and described by Dr Cunningham, and that again is smaller than the young male described by Mr J. W. Clark, which was taken in March, and the greater size of their specimens represents the growth of the animal during the autumn and winter months.

III. *Notes on the Skull of an aged male Hyperoodon rostratus from Shetland.* By Professor Sir WM. TURNER, M.B., LL.D., F.R.S.

(Read 16th January 1889.)

Two years ago I communicated to the Society a paper "on the occurrence of *Hyperoodon rostratus* in the Scottish Seas,"¹ and referred to several specimens which had come under my own observation. I pointed out that the specimens had been almost exclusively either females or young males. Only one British specimen of an adult male was, indeed, at that time known, viz., a cranium in the British Museum, obtained many years ago in the Orkneys, which, from the breadth of the maxillary crests, it was at one time customary to name *Hyperoodon latifrons* (J. E. Gray),² though it is now known

¹ Proc. Roy. Phys. Soc., vol. ix., p. 25, 1886.

² Zoology of Voyage of *Erebus* and *Terror*, p. 27, pl. 4, 1846.

to be an adult and probably aged male *Hyperoodon rostratus*.¹

In the autumn of 1887 my assistant, Mr James Simpson, whilst spending his vacation in Shetland, observed from the cliff above the Hole of Scaada a massive skull of a *Hyperoodon* lying some distance below him on the beach, and having communicated with Mr John Anderson of Northmavine on the subject, the skull was secured in the autumn of 1888, and presented by Mr Anderson to the Anatomical Museum of the University of Edinburgh. Mr Thomas Anderson has kindly written the following note on the animal:—"It was seen floating dead off the villions of Ure in March 1883. As the sea was too rough to launch a boat, the salvors from the rocks fixed a small anchor to it, and towed it along the cliffs till it was opposite the entrance of the tunnel leading from the sea to the Hole of Scaada, when it drifted on to the beach at the upper end of the Hole. It was flensed there, and the blubber yielded 260 gallons of oil. The whale was newly dead, as no part of it was decayed. No record of its dimensions or external appearance was taken, as the men who got it were more anxious to secure the blubber than to take measurements."

The skull had been lying on the beach from 1883 until it was removed for transmission to the Museum in 1888, and during that time its surface had been to some extent rubbed on the stones by the action of the waves, and unfortunately the slender part of the beak and the pterygoids had been broken off.

The skull was obviously that of an aged animal, for the sutures were obliterated, and the maxillary crests were of great height and thickness. Its dimensions may be made more evident, and the changes which age produces in the skull, by a comparison with the young male skull from Loch Ranza, referred to in my former communication.

¹ See Captain David Gray and Professor Flower, in *Proc. Zool. Soc.*, December 19, 1882; and Mr Thos. Southwell in *Trans. Norfolk and Norwich Naturalists' Soc.*, vol. iii., p. 476.

	Shetland. ♂ Aged.		Loch Ranza. ♂ Juv.	
Extreme length of skull,	End of beak broken off.			
	ft.	in.	ft.	in.
Height of skull at occipital crests,	1	9	1	5
„ „ maxillary crests, ¹	2	6	1	5½
Greatest breadth of anterior surface of maxillary crests,	0	8½	0	1
Least interval between upper surface of maxillary crests,	0	1½	0	5½
Height of maxillary crests above intermaxillary bone, 1	1	7	0	7
Greatest transverse breadth of skull behind orbits, 2	2	3½	1	8½

The skull from Orkney in the British Museum has also the end of the beak broken off. What is left of this skull is, according to Dr J. E. Gray, 5 feet 2 inches long, whilst what is left of my specimen is 4 feet 1½ inches. Dr Gray speaks of the maxillary crests as very thick, as nearly touching each other in front of the blow-hole, and as much higher than the hinder part of the skull ; but he does not give their numerical dimensions. In my specimen the maxillary crests in the aged skull were fully a foot higher than in the younger specimen, and whilst in the latter the summits both of the occipital and maxillary crests were almost in the same horizontal plane, in the aged skull the maxillary were 9 inches higher than the occipital crests. But the differences in breadth of the maxillary crests were equally striking. In the younger skull they formed a ridge both on their upper and anterior borders, which was not more than an inch wide at the free edge ; and, whilst the inner surface was almost vertical, the outer surface bulged outwards, and the crest was thickest about the middle.

In the aged skull each crest was almost vertical on its outer surface ; the inner surface was also nearly vertical for about two-thirds of the distance from the summit, when it became slightly concave, so that the interval between the two crests, which was at the summit only 1 inch at the narrowest spot, increased close to the intermaxillæ to 3 inches at the hinder end, and 4½ inches in front. Whilst the greatest breadth of the anterior surface of a crest was

¹ The height of the crests is modified according as the skull is made to rest on the mastoid processes or the pterygoids.



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p. 247.

8½ inches, that of the summit was only 5½ inches. The anterior surface was also flattened, roughly tuberculated, and sloped downwards and forwards so as to form an angle of 58° with the horizontal plane. The right crest was somewhat bigger than the left, and projected both a little further forward and distinctly further back, so as to approach nearer to the ascending part of the premaxilla. The greatest breadth between the outer borders of the two maxillary crests was 1 foot 5 inches.

From a comparison of the relative size of the maxillary crests and their intermediate interval in the young and aged male skulls, it is evident that the difference between them is mainly due to the growth of each crest inwards towards the mesial plane, which occasions great narrowing of the intermediate interval; and at the same time the vertical diameter of these crests increases, so that they form the summit of the skull and head.

On the left side of the head the interval between the posterior border of the maxillary crest and the front of the ascending part of the premaxilla was a little greater than on the right side, and in both the young and aged skulls measured 5 inches. The anterior nares were unsymmetrical, the right nasal and premaxilla being broader, and projecting more forward than the left in both skulls. In the young male the posterior wall of the nose was almost vertical; in the aged animal it was directed obliquely backwards, so that on looking vertically downwards on the anterior nares they were quite open in the young animal, but almost entirely overlapped by the nasals and ascending parts of the premaxillæ in the aged skull. In the aged skull also the occipital squama sloped upwards and forwards from the foramen magnum; in the young male it was nearly vertical.

The bones of the aged male skull were dense, hard, and, where the surface was not abraded by rubbing on the beach, almost porcellaneous in their character. Although portions of this skull were lost, it weighed 308 lbs.; whilst the younger male, also without a lower jaw, weighed only 37 lbs. The old skull, therefore, exceeds by 271 lbs. the weight of that of the young animal, and it is probable that this great

increase of weight in the skeleton of the head is compensated for by a great increase in the thickness of the blubber, so as to produce the bull-formed head which Captain David Gray has figured as characteristic of an aged male.

The period of the year (March) when the carcass of this animal was obtained by the fishermen is not without interest. As a rule *Hyperoodon rostratus* is caught on our coasts, or those of the north-west part of continental Europe, in the autumn, when the animal is making its annual migration from the Arctic Ocean to the south. Lilljeborg relates¹ that a female was stranded at Landskrona, in Sweden, in April 1823; but this aged male from Shetland is the only specimen which has been obtained as early as the month of March. Captain David Gray, however, states² that on the voyage northwards in the month of March, immediately after leaving the Shetland Isles, these whales are occasionally met with. Probably at that season they are migrating to the Arctic Ocean.

IV. *On the Structure and Classification of the Asterolepidæ.*

By Dr R. H. TRAQUAIR, F.R.S., F.G.S. [Plates I., II.]

(Read 21st November 1888.)

Of this remarkable and problematic group of Palæozoic Vertebrata, the genera with which I propose to deal in the present communication are *Asterolepis*, Eichwald, *Pterichthys*, Agassiz, *Bothriolepis*, Eichw., and *Microbrachius*, Traq. We shall commence with

PTERICHTHYS, Agassiz, 1840.

(= *Asterolepis*, Pander, pars, non Eichw., non H. Miller.)

The structure of *Pterichthys*, sadly misunderstood by Agassiz, was more satisfactorily discussed by Egerton (8); but the writer who in former times knew most about it was Hugh Miller. It is, indeed, strange that though Miller published in 1841 (3) wonderfully accurate figures both of its upper and under surfaces, Agassiz should have mistaken the belly for the back, and should have given in his "Old

¹ Memoir, translated in Royal Society's publications, p. 247.

² Proc. Zool. Soc., London, December 19, 1882.

Red" such an utterly bizarre and incorrect restoration, which has, moreover, been copied and recopied into so many text-books, down even to the present day.

A brief account of *Pterichthys* was given by M'Coy in his "Palæozoic Fossils," in which Hugh Miller's ideas as to the number and arrangement of the plates of the carapace are corroborated. No attempt is, however, made to go into the structure of the pectoral appendages, while as to the head he says that it is "covered by several irregular polygonal pieces, the exact form of which is still doubtful." The fin observable on the tail was regarded by M'Coy as an anal (6, p. 598 *et seq.*).

Pander, in his classical "Placodermen" (7), has given some figures of Scottish examples of *Pterichthys*, which, however, do not help us much with those details not already known. But assuming that *Asterolepis*, Eichwald, and *Pterichthys*, Agassiz, are synonymous terms, he added to his elaborate and valuable restoration of the Russian *Asterolepis ornatus* a tail and dorsal fin taken from the Scottish *Pterichthys* (pl. v., fig. 10); and I must agree with Lahusen (11) in protesting against this figure having been reproduced in various works not only as "*Pterichthys*" but even as one or other of the species of *Pterichthys* occurring in Scotland.¹

There is therefore abundant reason for going afresh into the anatomy of the organisms discovered by Hugh Miller, Malcolmson, and Stables, and named by Agassiz *Pterichthys*. The special structure of the head and limbs was hitherto almost unknown, and there is also room for rectification as regards the body-carapace and tail. And this investigation is also of great systematic importance as bearing on the question as to whether Pander was right in maintaining the identity of Agassiz's genus with Eichwald's *Asterolepis*; for as "*Asterolepis*" has the priority, the only ground for maintaining *Pterichthys*, were Pander right in his contention, would be the inadequacy of Eichwald's original description of *Asterolepis*, and then that name would

¹ For instance as "*Pterichthys Milleri*" in Owen's "Palæontology" (1860), p. 121, as "*Pterichthys cornutus*" in Prestwich's "Geology" (1888), vol. ii., p. 80.

have to be cancelled, as it cannot legitimately be applied to the great Coccothoean, named *Homosteus* by Asmuss, and familiarly known to us as Hugh Miller's "*Asterolepis* of Stromness." With that question is also bound up that of the distinction of *Bothriolepis*, Eichwald, a genus also considered by Pander to be synonymous with *Asterolepis*; for although Lahusen (11) and Trautschold (12) have given good reasons for retaining it as valid, the latest writer on the subject, Whiteaves, treats the question as one concerning which certainty has not yet been attained (15).

Head.—The cephalic shield of *Pterichthys* (Pl. I., Fig. 1) is of a semicircular or, rather, semi-elliptical shape, rounded in front and truncated behind, where it joins the body-carapace. In the centre it shows a transverse opening, distinctly represented in Hugh Miller's early drawing (3, pl. i., fig. 1), and which, though it was not mentioned by Agassiz, is nevertheless indicated in his figures both of *Pterichthys testudinarius* (4, tab. iv., fig. 2) and *Pamphractus hydrophilus* (ib., tab. iv., fig. 6, and tab. vi., fig. 2). This opening, slightly contracted in the middle and expanded on each side, I shall simply call the *median opening*, though it has usually been regarded as an "orbit," and more recently Cope has put forward the view that it represents the mouth in the Tunicata (17). It is entirely filled up by a small plate or system of plates rarely seen in *Pterichthys*, but, as we shall see further on, well displayed in many specimens of the allied genus *Bothriolepis*. The nuchal region is occupied by a plate, the *median occipital* (*m. o.*), shaped somewhat like the conventional royal "crown," but without the pinnacle in the centre. Marginally it shows six aspects or articulations—one posterior, straight, articulating with the median dorsal plate of the carapace; two lateral, each of which passes first forwards and then obliquely forwards and outwards, articulating with the lateral occipital (*l. o.*); two antero-lateral, passing at an angle forwards and inwards, articulating with the lateral plate on each side; and one anterior, retracted in the centre, so as to form a wide re-entering angle in which the correspondingly angulated posterior aspect of the postmedian plate (*p. m.*) is received.



I have seen no trace in *Pterichthys* of the new plate which Pander figured in *Asterolepis* (Pl. I, Fig. 1, 2, 3) under the name of "os terminale," a bone located at the margin of the cranial shield in front of the premedian right and left lateral. This bone Pander stated he had never found perfect in the Old Red formation of Sweden, but thought that he found it in the fossil *Pterichthys* (*os*, tab. vi, fig. 3). Nevertheless, in copying the figure here quoted with numerous examples of *Pterichthys*, I am satisfied that the same bone should have marking off the "os terminale" in the same manner, belonging to the lateral line system, which runs to the part of the head.

Of the small, narrow, doubly curved plates Pander "Oberkiefer" (J. tab. vi, fig. 1, 2, 3) has nothing; but the oblong plates which he named "Kinnlade" or "maxilla inferior" are present in numerous examples of the fossil *Pterichthys*. These plates composed lower jaw (max. Pl. I, Fig. 3) consist of two or three what narrow oblong plates, meeting each other in a central line and placed transversely on the side of the head right in front of the ventral plate (part of the ventral body-carapace). Each is narrower at the outer end, at the inner end, and somewhat curved downwards, so that they occur displaced forwards, even to a point directly in front of the head. These plates may well be considered the inferior (or posterior) boundary of the snout, but it is clear that their mode of working must have been quite different from that of the mandible of ordinary Vertebrates.

Before leaving the head of *Pterichthys*, it may be well to point out the distribution of the lateral line system in this part. In all the Asterolepidae, as well as in the *Ammonoites*, this system consists of grooves, which are up to a certain point often been mistaken for sutures, and a double, but they do not occur on the inferior surface of the head and their connexion with a similar groove running along each side of the body amply demonstrates their true nature. In *Pterichthys* each cephalic groove (Pl. I, Figs. 1 and 2, represented by the double dotted lines) passes from the dorsal-lateral

posed to abolish the latter synonym. We have also generic distinction on a articulation of the arms "horacic" plates exist no er.

able resemblance in the of the head and of the er I must make a few as found any trace of the his restoration of *Asterolepis* admitted that he had never dstone of Livonia; yet ms probable enough if, margin of the premedian apposition of another nothing like the "os" may be the central part poses up the "orbit" in is in *Pterichthys* an tion as that shown in s not seem to project margin of the cephalic

epis have hitherto been is natural that no tail with the body; Pander covering of this part ld Red of Russia, and ts known as *Psammodontus unilaterialis*, Eichw., and *Ctenacanthus serratus*. I had the opportunity and can only say that, and figures, there does connecting them with dmitted that they differ ing composed of vaso- ed of true bone. It is

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On each side of the median occipital is the *lateral occipital* (*l. o.*), of an irregularly pentagonal shape and having one side internal, articulating with the median occipital; two posterior, articulating with the anterior dorso-lateral (*a. d. l.*) of the carapace; one anterior, articulating with the lateral plate of the head; and one external, joined to the *angular* (*ag.*). The latter (postmarginal, Owen) is a very small plate, also forming part of the cranial shield behind the lateral plate. In front of the median occipital, which it entirely separates from the median opening, is a transversely elongated plate, the *postmedian* (*pt. m.*), broadest in the middle, narrow at each end. Its gently convex anterior margin forms the posterior boundary of the median opening; its posterior margin, obtusely angulated, fills up the re-entering angle of the front of the median occipital, while each narrow extremity or outer margin articulates with the lateral cranial plate.

Each *lateral plate* (*l.*) is of an antero-posteriorly elongated form, and may be described as having four margins. The very irregular inner one articulates with the median occipital and postmedian, is then notched to form the outer margin of the median opening, in front of which it articulates with the *premedian* (*p. m.*); the outer margin, slightly concave, articulates with the *extralateral* (*e. l.*), the posterior with the external occipital, while the short anterior one forms part of the front margin of the cranial shield.

The remaining plate (*e. l.*) of the cranial shield is that which in *Asterolepis* has been named "opercular" by Pander, "marginal" by Owen; but I prefer to call it *extralateral*. Forming the lateral margin of the buckler external to the lateral plate on each side, this element attains a large size in *Pterichthys*, and seems to have been only loosely articulated to the side of the head, as it so frequently occurs dislocated and removed from its position, while the other cranial plates still cohere together. In Fig. 4 I have represented it in an isolated condition, where it will be seen that its inner margin, which must have been largely overlapped by the lateral plate, shows a peculiar notch a little in front of the middle. (Compare Pander's figure of the same plate in *Asterolepis* (7, tab. vi., fig. 1, No. 3).)

I have seen no trace in *Pterichthys* of the narrow plate which Pander figured in *Asterolepis* (7, tab. vi., fig. 1, No. 2) under the name of "os terminale," as forming the anterior margin of the cranial shield in front of the premedian and right and left laterals. This bone Pander admitted he had never found perfect in the Old Red Sandstone of Livonia, but thought that he found it *in situ* in Scottish examples of *Pterichthys* (*ib.*, tab. vi., fig. 5). Nevertheless, on comparing the figure here quoted with numerous examples of *Pterichthys*, I am satisfied that the suture there indicated as marking off the "os terminale" is only the transverse groove, belonging to the lateral line system, which crosses the front part of the head.

Of the small, narrow, doubly curved ossicle designated by Pander "Oberkiefer" (7, tab. iv., fig. 1, No. 1) I know nothing; but the oblong plates which he named "Unterkinnlade" or "maxilla inferior," are preserved *in situ* in numerous examples of the Scottish *Pterichthys*. This supposed lower jaw (*mn.*, Pl. I., Fig. 2) consists of two somewhat narrow oblong plates, meeting each other in the middle line and placed transversely on the under surface of the head right in front of the semilunar plates (*s. l.*) of the ventral body-carapace. Each is narrower at the outer than at the inner end, and somewhat concave above; frequently they occur displaced forwards, even to a position altogether in front of the head. These plates may indeed have formed the inferior (or posterior) boundary of the mouth; but it is clear that their mode of working must have been rather different from that of the mandible of ordinary Vertebrata.

Before leaving the head of *Pterichthys*, it may be well to point out the distribution of the lateral line system on this part. In all the Asterolepidæ, as well as in the Coccosteidæ, this system consists of grooves, which are apt to be, and have often been, mistaken for sutures, actual or obsolete; but they do not occur on the inferior surfaces of the bones, and their connexion with a similar groove running along each side of the body amply demonstrates their true nature. In *Pterichthys* each cephalic groove (Pl. I., Figs. 1 and 2, represented by the double dotted lines) passes from the dorso-lateral

plate of the body on to the external occipital, where it at once bifurcates, a transverse branch passing across over the posterior part of the median occipital to join its fellow of the opposite side. The main groove then runs forward on the lateral cranial plate, and, arriving in front of the median opening, it bends inwards to join the opposite groove on the premedian plate, on which it forms a small backward flexure. This course is altogether similar to that in *Asterolepis*; but as we shall see, it is in some particulars different from the arrangement seen in *Bothriolepis*.

Body-carapace.—This, as already shown by Sir Philip Egerton and Hugh Miller, is nearly quite flat below, high and vaulted above, the sides rising at right angles to the base; as the former author says, "the contour must have had considerable resemblance to a high-backed tortoise with the carapace culminating near the anterior margin," the transverse section being "not unlike the outline of a stirrup-iron." It is composed altogether of thirteen plates, being two more than the number given by Hugh Miller, but agreeing in this respect with *Asterolepis* as described by Pander.

The general form of these plates is already so well known from the descriptions of Hugh Miller and Egerton, that I need here only allude to certain matters of detail which require correction, some of them, however, being of considerable importance. In Pl. I., Figs. 1, 2, and 3, I have represented the outlines of the body-plates as seen from the back, belly, and side respectively, the thick black lines representing overlapping edges, as seen on the external surface, the thin ones those which are overlapped, and which, consequently, are concealed externally when the plates are *in situ*,

The first point of importance is the presence of two small narrow plates (*s. l.*, Fig. 2), each of which occupies a space cut out from the inner half of the anterior margin of the anterior ventro-lateral (*a. v. l.*), and is in contact mesially with its fellow of the opposite side. This is Pander's *semilunar* in *Asterolepis* (7, pl. vi., fig. 1), and though not mentioned in the descriptions of Hugh Miller and Sir Philip Egerton, the space which it occupied is distinctly seen in one of Sir Philip's figures (8, p. 305, fig. 2).

Next, as to the anterior ventro-lateral plate itself and the mode of articulation of the arms. Notwithstanding the contrary opinion of Hugh Miller and M'Coy, Sir Philip Egerton strongly maintained that the arms were articulated to separate "thoracic" plates, marked off by a distinct line of suture from the anterior ventro-lateral; and so confident was he in this opinion, that he went so far as to say that he was "at a loss to conceive how Professor Pander can have been led to assign the attachment of the arms to the ventro-lateral plates as shown on the magnified figure on tab. vi. of his magnificent work on the Devonian fishes, although in the preceding plate these organs are correctly drawn as appended to the thoracic plate" (9, p. 105). Now in this matter Pander's accuracy cannot be impugned as far as *Asterolepis* is concerned, for the Russian plates of this genus were found isolated and uncompressed, and the place of articulation of the arm can easily be verified on a specimen of the anterior ventro-lateral plate of *A. ornatus* in the British Museum collection. And as regards Sir Philip's appeal to Pander's figs. 5 and 9 on tab. v. of his work, in which the "thoracic" plates seem to be represented in specimens of *Pterichthys* from Lethen, he could not surely have read the author's explanation of these figures, in which it is expressly stated that this appearance is due to fracture!

Nevertheless, accepting Pander's description of these parts to hold good for *Asterolepis* and Egerton's for *Pterichthys*, Beyrich (10), Lahusen (11), and Zittel (16) have sought herein to find a diagnostic mark between the two genera; but this idea I cannot corroborate. Careful study of a large series of Scottish examples of *Pterichthys* has convinced me beyond all doubt that Egerton was in error on this point, and that his "thoracic" plates are simply parts of the anterior ventro-laterals, separated not by a suture, but by an internally projecting ridge, which, in crushed and decorticated specimens, gives the false impression of a division. I may add that the species *macrocephalus*, in connection with which Sir Philip expressed his opinion so strongly, is not a *Pterichthys*, but a *Bothriolepis*, and that isolated plates of the larger species of the same genus demonstrate absolutely the unity of the

anterior ventro-lateral and the position upon it of the pectoral articulation.

The articular fossa on the outer side of the anterior ventro-lateral in *Pterichthys*, with its contained helmet-process grasped by the articular plates of the arm, and the foramen for the passage of the vessels and nerves to the same, seems to be conformed exactly as in *Asterolepis*; and as these parts have been so well described by Pander from Russian specimens of the latter genus, it is needless at present to enter into detail respecting them. If the Scottish and Russian genera are distinct, the diagnosis must be founded on something else than the articulation of the limbs.

Thirdly, as to the articulation of the body-plates with each other. Sir Philip Egerton states that "all the plates of the carapace, with the exception of the lozenge-shaped plate *g* (of the under surface), are united by simple sutures; this, on the contrary, is attached to its neighbours by broad squamous sutures, the lateral bones overlapping its margins on all sides" (8, p. 306); but in the same paper he quotes Hugh Miller to the effect that the two median dorsal plates overlapped some neighbouring ones, and were themselves overlapped by others. Now my observations show that all the plates of the carapace were connected with each other by overlapping or squamous sutures, a marginal band along the internal surface of the overlapping plate being thinned off to fit on to a corresponding band along the margin of the outer surface of the one overlapped. The hexagonal *anterior dorsal plate* (*a. d.*) in this way overlaps the anterior dorso-laterals, but is itself overlapped along its postero-lateral margins by the posterior dorso-laterals, and also behind by the posterior median dorsal, though in this latter case the contrary is stated by Hugh Miller (*ib.*, p. 309).

The *anterior dorso-lateral* (*a. d. l.*) overlaps the posterior dorso-lateral, but is itself overlapped by the anterior median dorsal and by the anterior ventro-lateral.

The *posterior dorso-lateral* (*p. d. l.*) overlaps the anterior median dorsal, but is itself overlapped by all the other plates with which it is in contact, viz., the posterior median dorsal,

the anterior dorso-lateral, and the anterior and posterior ventro-laterals.

The anterior ventro-lateral overlaps the anterior and posterior dorso-laterals, the posterior ventro-lateral, and the median ventral, while the right one overlaps its fellow of the opposite side in the mesial line.

The posterior ventro-lateral overlaps the median ventral and the posterior dorso-lateral, but is in turn overlapped by the anterior ventro-lateral. In the middle line the plate of the left side overlaps its fellow.

The Arms.—These are comparatively short, as in *Asterolepis*, and I find their structure to be essentially similar to those in that genus as described and figured by Pander. They are hollow, divided by a tranverse joint into two segments, proximal and distal, rather flattened above and below, especially towards the extremities, and composed of numerous plates, which have much the same contour above and below. In the proximal segment (Pl. I., Figs. 1 and 2) we have the following plates:—two *articular* (*ar*), dorsal and ventral, which grasp the helmet-process of the anterior ventro-lateral plate; one *internal articular*, only visible from the inner side of the limb, and therefore not shown in the figures; one *external marginal* (*m*), extending nearly along the whole of the outer aspect of the segment; one shorter, *internal marginal*, and two *anconal*, or elbow-pieces (*a*), dorsal and ventral, somewhat triangular in shape, their apices directed forwards to meet the posterior extremities of the articulars, their convexly rounded bases articulating with the central plates of the distal segment. The distal segment or “forearm” consists of two *centrals* (*c*), dorsal and ventral, rhombic in shape, with the acute angles truncated, one acutely pointed *terminal* (*t*), and four *marginals* (*m*), of which two follow each other on the outer aspect, and two are similarly placed on the inner aspect of the limb.

The Tail.—In most Scottish examples of *Pterichthys* more or less perfect remains occur of a tail, covered with small rounded or somewhat hexagonal, slightly imbricating scales, which are arranged in longitudinal rows and also in transverse bands, the scales of one band alternating with those of

the next; on the dorsal aspect close behind the carapace is also a small fin (Pl. I, Fig. 3). Along the dorsal margin the scales are different in shape from those on the sides; in front of the fin they seem to be in the form of a few narrow, longitudinal, median plates; behind it they are elongated and imbricating, the arrangement reminding us of the so-called fulcra or V-scales along the extremity of the tail of an Acipenseroid fish; but whether they are monostichous or distichous it is hard to determine. The external sculpture of the scales is rarely seen, and can therefore hardly be available as a specific character. (See Agassiz's figure of the scales of *Pt. cornutus* in 4, pl. ii, fig. 3.)

The fin is triangular-acuminate in shape, and seems to have been covered with small scales, no distinct rays being seen. At least two specially prominent elongated scales are placed along its anterior margin, producing an appearance which has been mistaken for that of a spine. The position of this fin is undoubtedly dorsal, as held by Hugh Miller, and not anal, as supposed by M'Coy (6, p. 599). Sir Philip Egerton supposed that in addition to the dorsal two ventrals were also present (9 a, p. 127); but having examined the specimen, now in the British Museum, on which he founded this conclusion, I find that the two supposed ventrals are merely parts of the dorsal separated by a little fault or dislocation in the stone.

As regards the British species of *Pterichthys* I have already indicated my views in the *Geological Magazine* of this month. Their characters, so far as I can see, are entirely dependent on slight differences in the shape of the carapace and of the terminal segment of the arm, so that I have often suspected that after all only one "good" species was really represented. Were this view to be adopted, then the name *Pterichthys Milleri*, Ag., would include all the others as varieties.

ASTEROLEPIS, Eichwald (published April 1840).

(= *Asterolepis*, Agassiz, pars, non Hugh Miller; *Pterichthys*, Owen, Whiteaves, et cet. auct. pars, non Agassiz.)

We have seen that Pander maintained the identity of *Asterolepis*, Eichwald, with *Pterichthys*, Agassiz; and as the

priority lay with *Asterolepis*, he proposed to abolish the latter name altogether, as being a mere synonym. We have also seen that the attempt to base a generic distinction on a supposed difference in the mode of articulation of the arms cannot hold good, as Egerton's "thoracic" plates exist no more in the one case than in the other.

There is certainly a very remarkable resemblance in the form and arrangement of the plates of the head and of the arms, though as regards the former I must make a few remarks. I have never in *Pterichthys* found any trace of the "*os terminale*" figured by Pander in his restoration of *Asterolepis*, and concerning which he admitted that he had never found it perfect in the Old Red Sandstone of Livonia; yet its existence in the Russian form seems probable enough if, as described by Pander, the anterior margin of the premedian shows a sutural surface indicating the apposition of another plate in front of it. I have seen nothing like the "*os dubium*" in *Pterichthys*, though it may be the central part of an arrangement like that which closes up the "orbit" in *Bothriolepis*. Lastly, although there is in *Pterichthys* an "angular" element in the same position as that shown in Pander's figure of *Asterolepis*, it does not seem to project backwards in the same way from the margin of the cephalic shield.

As the plates of the Russian *Asterolepis* have hitherto been found only in a disjointed condition, it is natural that no tail should have occurred in apposition with the body; Pander has, however, referred to the dermal covering of this part certain curious bodies found in the Old Red of Russia, and with which he considered the fragments known as *Psammodlepis*, Ag., *Cheirolepis splendens* and *unilateralis*, Eichw., *Microlepis exilis* and *lepidus*, Eichw., and *Ctenacanthus serrulatus*, Ag., to be identical. I have never had the opportunity of examining any of these bodies, and can only say that, judging from Pander's descriptions and figures, there does not seem to me to be any reason for connecting them with *Asterolepis*, especially as he himself admitted that they differ in structure from the body-plates, being composed of vasodentine, while the latter are composed of true bone. It is

therefore clear that no comparison can be instituted between *Pterichthys* and *Asterolepis* so far as the tail is concerned.

There remains the body-carapace. This is more depressed than in *Pterichthys*, but the number and general arrangement of the plates are the same. As regards their mode of articulation Pander does not enter into any great detail either in his figures or text; but he makes one important statement regarding the anterior median dorsal which demands attention, namely, that its lateral margins have on the under side narrow squamous surfaces which overlap both the anterior and posterior dorso-laterals ("unter welche sich die beiden seitlichen Schilder 12 und 13 unterschieben"), a statement borne out also by his figures of the plates in question. Now we have seen that in *Pterichthys* the anterior median dorsal plate does not overlap the posterior dorso-lateral, but is certainly overlapped by it, so that we have in this circumstance a quite tangible mark of distinction between the two genera.

I have not seen the anterior dorso-median plate of *Asterolepis ornatus*; but in the Upper Old Red Sandstone of Nairnshire remains of a large *Asterolepid* are not uncommon in which this plate certainly had the same relations to the surrounding ones as Pander has described in the Russian form. This is the *Coccosteus maximus* of Agassiz (4, p. 137, tab. xxx. a, figs. 17 and 18), who supposed the plate in question was a median ventral, while Hugh Miller, with a better conception of its real nature, wished to consider it the dorsal plate of "*Pterichthys*" *major*. Having now got together a very instructive set of its plates, I find that this creature is not *Pterichthys major*, which is in reality a *Bothriolepis*, but a species closely resembling the *Pterichthys* of the lower beds in all essential respects save its depressed form and the mode of articulation of its anterior median dorsal plate. In Pl. II., Figs. 1 and 2, I have given outlines of the upper and lower aspects of this plate, the articular surfaces being shaded by horizontal lines. There it will be observed that on the outer aspect (Fig. 1) there is no articular surface but the one, z, at the posterior margin which is overlapped by the posterior median dorsal, while on the under

surface (Fig. 2) the antero- and postero-lateral margins show each a narrow surface, x and y , which overlap the anterior and posterior dorso-laterals respectively. Isolated specimens of the dorso-lateral plates show corresponding surfaces on their outer aspects. The rest of the creature, as I have said, resembles *Pterichthys*, but the carapace is more depressed, the anterior and posterior dorso-lateral plates being narrower. The limbs are short and are similar in construction to those of the last-named genus; and though I have seen little of the head, what I have seen appears to correspond. As regards the tail, as no really entire specimen of the creature has occurred, it is difficult to speculate; but numerous rounded scale-like bodies occurring in the same beds may possibly be referable to this part.

I therefore propose to refer this species to *Asterolepis* under the name of *A. maximus*, Ag., sp., the name being fortunately suited to its large size, as median dorsal plates sometimes attain a length of 6 inches.

BOTHRIOLEPIS, Eichwald, 1840.

(*Pamphractus*, Agassiz; *Homothorax*, Ag.; *Asterolepis*, Pander, pars;
Pterichthys, Ag. et cet. auct. pars; *Bothriolepis*, Ag., pars.)

Bothriolepis was founded by Eichwald upon certain plates or fragments of plates occurring in the Old Red Sandstone of Russia which differed from those of *Asterolepis* in having the surface pitted instead of tuberculated. From his very brief original description (1) it is evident that he had before him fragments of a creature allied to *Pterichthys*; but unfortunately he ascribed teeth to it, and imagined its scutes to be arranged in longitudinal rows, like those of the sturgeons, with a rough shagreened skin or smooth enamelled scales between them. By Agassiz *Bothriolepis* was placed among the "Coelacanthi," and though the plates figured by him as *B. ornatus*, Eichw., are Asterolepid (or Pterichthyid) in character, he gave the name of *Bothriolepis favosus* to an undoubted Rhizodont. In establishing the family of Placodermata to include the Cephalaspidæ of Agassiz except *Cephalaspis*, M'Coy (5) rightly included *Bothriolepis*, and Pander went so far as to assign to it a place among the

synonyms of *Asterolepis*, Eichw., along with *Pterichthys*, Ag., and many other names.

However, the dorsal plate figured later on by Eichwald (2, pl. lvi., fig. 3) as belonging to his *B. ornatus*, not only stamps it as *Asterolepid*, but leads us also to suspect that it is generically different both from *Asterolepis* and *Pterichthys*, and that this is the case was clearly shown by Lahusen (11). Describing a head with a portion of the body attached, as well as the two median dorsal plates and some other fragments of the body and arms of a species to which he gave the name of *B. Panderi*, Lahusen pointed out, first that the course of the cephalic furrows (lateral line system) was not the same as in *Asterolepis*; second, that the postmedian plate was different in shape; third, that there was no *os terminale*; fourth, that the articular plates of the arms were longer. But when he speaks of the arms being more simple in structure than those of *Asterolepis*, and we compare his figures, it is quite clear that he had before him only the proximal segment of the limb; and it must also be noted that in some cases he regards the grooves of the cephalic lateral line system as sutures, or at least as former sutures, and so very considerably increases the number of bones which he allots to the cranial shield.

Trautschold's contribution to the structure of *Bothriolepis*, published shortly afterwards (12), consists largely of corrections of Lahusen's paper in matters of detail. He also formulates the differences between the heads of *Bothriolepis* and *Asterolepis*, laying stress on much the same points as Lahusen, but adding that the angular and opercular elements (Pander) found in the latter are wanting in the former genus, though, strangely enough, the angular is represented in the diagram which he gives of the head in *Bothriolepis*. Noteworthy it is that he mentions having found in one specimen a lid or cover to the "orbit," and accurately fitting it. As regards the arms, of which he had no complete specimens, he pointed out certain differences in the arrangement of their constituent plates, and considers it doubtful whether the limb was divided into proximal and distal portions, as in *Asterolepis*.

The discovery by the officers of the Canadian Geological

Survey of numerous well-preserved entire specimens of *Bothriolepis* in the Upper Devonian rocks of Scanmenac Bay enabled Mr Whiteaves to give a description (13, 14, 15), accompanied by excellent figures, of a new species of the genus, to which he gave the name of *Pterichthys (Bothriolepis) canadensis*. These specimens are certainly the finest examples of Asterolepid remains yet discovered, and clearly show all the salient features of *Bothriolepis* in a manner never before exhibited. Unfortunately, Mr Whiteaves does not seem to have had complete access to the literature of the subject, as he makes no reference to the papers of Egerton and Beyrich on *Pterichthys*, or to those of Lahusen and Trautschold on *Bothriolepis*, and consequently does not seem to be aware that the identity of *Asterolepis*, Eichwald and Pander, and *Pterichthys*, Agassiz, had ever been questioned, or that very tangible differences between *Bothriolepis* and *Asterolepis* had been already pointed out; for, as regards the former, he says, "It is still open to question, however, whether the genus *Bothriolepis* is or is not a valid one, and sufficiently distinct from *Pterichthys*" (15, p. 106).

However, he bases his reference of the Canadian species to *Bothriolepis* on the sculpture of the plates, pointing out some discrepancies in the plates of the head compared with those in Pander's restoration of "*Pterichthys*" (= *Asterolepis*); and noticing the absence of a tail, he contents himself with saying, "It seems therefore highly probable that *Bothriolepis* will prove to be distinct from *Pterichthys* proper." Even as regards the species, he seems to be in doubt as to whether or not it is distinct from *B. ornatus* of Eichwald.

But if the generic distinctions between *Asterolepis* and *Pterichthys* are but slight, nothing can be more salient than those which distinguish *Bothriolepis* from both, as will be seen from the following sketch:—

Head.—The median occipital (*m. occ.*, Pl. II., Fig. 6) has its lateral margins more perpendicular to the posterior one, the anterior margin shows not merely a shallow re-entering angle for the postmedian plate, but a deep semi-elliptical notch or excavation. The postmedian is small, narrow, semi-elliptical in shape, and, except its anterior

margin, is entirely received in the aforesaid notch of the median occipital, not extending on each side to join the laterals, as in *Pterichthys* and *Asterolepis*. The laterals (*l.*) are much broader, while the extra-laterals (*s. l.*, B in Whiteaves's figure) are very small and narrow; but I have not seen the still smaller plate which Whiteaves figures as A in front of the last-named.

The pattern of the cephalic lateral-line grooves is considerably different from that in *Asterolepis* and *Pterichthys*. No transverse commissure unites the lateral groove of each side across the occipital plates, as in those genera; but in front, just at its inward flexure on the lateral plate, a conspicuous branch is given off, which runs forwards and outwards to the margin of the shield, while immediately behind the origin of this branch, and on the inner side of the main groove, a small ear-shaped mark is often, though not always, seen. On the median occipital two slighter grooves are seen, forming an angle with each other behind, whence, diverging obliquely forwards and outwards, they pass also over the lateral plates and terminate near the flexure of the great groove, close behind the origin of its small outer branch.

These grooves are only superficial, and have nothing to do with sutures, either present or former; nevertheless, their having been considered as such has, as in the case of *Cocco-steus*, given rise to confusion in the enumeration of the plates of the cranial shield. Owing to this source of fallacy, Whiteaves, like Lahusen, has numbered, in his figure of the head of *B. canadensis*, no less than seven plates more than what really exist, namely, his No. 2 in front, and on each side his Nos. 2 *a*, 3, and 9 *a*, though he owns that 9 *a* "may possibly be a part of the postlateral" (external occipital). That is undoubtedly the case, and in like manner 2 *a* and 3 are portions of his prelateral (lateral) and 2 of the premedian. Nos. 2 and 2 *a* he regards as equal to the "*os terminale*" in *Asterolepis*; but if we turn to Pander's figure (7, tab. vi., fig. 1) we shall find that similar divisions are marked off by a similar groove on the premedian and lateral plates altogether independently of the division between these plates and the *os terminale*.

The median or "orbital" opening is in perfect specimens of the head of *Bothriolepis* filled up by a system of plates, being the "Decke" already noted by Trautschold. Whiteaves describes the arrangement as consisting of four elements, one central, like Pander's "*os dubium*," one anterior, and two lateral, of a rounded form, stating besides that the anterior one shows a remarkable slender process passing from the middle of its anterior surface right down through the head. I have not seen these plates in *B. canadensis*, but the "lid" is well shown in two specimens of *B. hydrophilus* in the Edinburgh Museum, in which the rounded lateral parts are seen to be very convex above. I cannot in these specimens trace any separation into distinct plates; but this may be due to mode of preservation.

Whether this median opening represents morphologically the mouth of the Tunicata, as Prof. Cope has suggested (17, 18), or not, the lateral convexities of the lid distinctly indicate that it covered a paired organ or pair of organs; and what paired organs could we more readily suppose to occupy this position than the eyes? But of what use could the eyes be if covered above by an opaque bony roof? Here I would venture a suggestion. May not the slender descending process described by Whiteaves be for the attachment of muscles arising from the inner aspect of the shield, which, on contraction, would elevate the entire lid above the level of the surrounding cranial plates, and enable the eyes to see out from below its margins? I do not put forward this theory with any notion of infallibility, but it does seem to me more consistent with the actual arrangement of the parts than that which supposes the median opening to be a mouth, the position of which was, I think, more probably on the under surface of the front of the head.

On the under surface of the head Whiteaves figures two plates (13, pl. vii., fig. 1, No. 15), of which he says that they "no doubt correspond to the plates which Pander calls the lower maxillæ." Except that their anterior margins come too far forwards, these plates do remind us of the pair seen in *Pterichthys* immediately in front of the semilunars, and which Pander in *Asterolepis* has interpreted as "Unter-

kiefer." Is it not possible that the exceeding closeness of their anterior margins to the edge of the cranial shield in Whiteaves's figure may be due to a slight forward displacement, such as often occurs in *Pterichthys* to a much greater extent? In a specimen of *B. canadensis* in the Edinburgh Museum remains of these plates occur, which evidently are so displaced, as they are shoved forwards quite over the edge of the cranial shield.

I have not seen the small median plate which Whiteaves (same figure, No. 18) represents immediately behind the two last mentioned, and concerning which he remarks, "Judging by analogies with the *Asterolepis* of Hugh Miller, but not of Pander, this may have been the hyoid plate." Unfortunately for this comparison, the "hyoid" plate of Hugh Miller's *Asterolepis* (= *Homosteus*) was, thirty years ago, determined to be the median dorsal plate of its carapace (7, p. 76).

Body-carapace.—This is more depressed in *Bothriolepis* than in *Pterichthys*, has a dorso-lateral angulated margin as well as a ventro-lateral one, and the dorsal surface is broader than the ventral one. The median dorsal plates are not so acutely elevated mesially as in *Pterichthys*; in some species they are only gently convex on the upper aspect. The anterior median dorsal, usually rather wide in its shape, articulates as in *Pterichthys* (but not as in *Asterolepis*), its antero-lateral margin overlapping the anterior dorso-lateral, while the postero-lateral margin is, on the other hand, overlapped by the posterior dorso-lateral. The inner surface of this anterior median dorsal (Pl. II., Fig. 3) shows a sharp median ridge, from which anteriorly two short branches are seen to diverge at acute angles forwards and outwards. On the inferior surface of the body the anterior ventro-laterals (Pl. II., Fig. 5) show a peculiarity in shape which distinguishes them from the corresponding plates in *Pterichthys* and *Asterolepis* in not exhibiting in front the prominent emargination for the semilunar plates seen in those genera. In fact, no precisely similar semilunar plates exist, though these seem to be represented by a single small triangular one occupying the median notch at the union of the two anterior ventro-laterals. This is figured by Whiteaves in *B. cana-*

densis (tab. et fig. cit., No. 17), and it is indicated, though, obscurely, in many specimens of *B. hydrophilus* (Pl. II., Fig. 5).

The lateral-line groove is continued on the body-carapace from the external occipital along the dorso-lateral plates on each side immediately below their longitudinal flexure. In addition to this, another groove in the form of an inverted V is seen on the dorsal surface, the apex of the V being a little in front of the middle of the anterior median dorsal plate, while its legs extend outwards and backwards over the posterior dorso-lateral (see Pl. II., Fig. 4).

Arms.—The pectoral limbs in *Bothriolepis* are distinguished from those of both *Pterichthys* and *Asterolepis* by their greater length, which usually equals or even exceeds that of the carapace, and this is due chiefly to the greater proportional extent of the proximal segment of each. Consequently the articular and marginal plates of that segment are of greater length than in those two genera; but what is more remarkable is, that the anconeal element (Pl. II., Fig. 4, a) is reduced to a small rounded plate on the dorsal, and apparently entirely wanting on the ventral aspect of the limb; so that beyond the articulators the marginals are entirely in contact with each other on the ventral side, and only separated towards their extremities on the dorsal. In so far as the proximal joint is concerned, the limb of *Bothriolepis* may be said to be simpler in construction than in *Pterichthys*; but this is not true of the distal part, in which both the central and marginal rows contain each at least one additional plate.

Tail.—It is remarkable that no tail is seen in *Bothriolepis*, although numerous specimens both of *B. canadensis* and *B. hydrophilus* seem perfect in every other respect. It is therefore perfectly plain that caudal scales were absent, though it does not seem to me quite so safe to assume that no caudal appendage was ever present; for the posterior aspect of the carapace shows a large opening just as in *Pterichthys*, out of which it is difficult to conceive that absolutely no body-prolongation ever proceeded, and it does seem quite possible that a tail might have existed, though unprovided with hard

The anterior dorso-median is peculiarly broad in shape. Its antero-lateral margin on each side first envelops the anterior dorso-lateral, and is then overlapped by it, this relation of the plates to each other being thus suddenly reversed. Behind this the postero-lateral and posterior margins of the plate are, as in *Pterichthys* and *Bothriolepis*, overlapped by the posterior dorso-lateral and the posterior dorso-median; the last-mentioned plate shows posteriorly a prominent angular point, projecting over the hinder opening of the carapace. On the underside the median ventral plate is extremely small. The arms are short, slender, and pointed; the plates of the head, which is large, are not well enough preserved to be readable. The outer surface of the body-plates is minutely tuberculated, the tubercles often tending to confluence in concentric lines.

In the form of the carapace *Microbrachius* resembles *Bothriolepis*, but the arms are short, and the mode of articulation of the anterior dorso-median plate is altogether peculiar. Only the type species, *Microbrachius Dickii*, Peach, sp., is known.

I have no material at present to enable me to enter into the discussion of *Actinolepis*, Ag., or *Chelyophorus*, Ag., of which the former at least is pretty certainly Asterolepid, as already noticed by Miller and Egerton; and the discussion of the general affinities of the group will form the subject of a subsequent communication.

LIST OF WORKS REFERRED TO.

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EXPLANATION OF THE PLATES.

(In all the figures the same letters refer to the same things.)

<i>m. occ.</i> Median occipital.	<i>p. m. d.</i> Posterior median dorsal.
<i>l. occ.</i> Lateral occipital.	<i>a. d. l.</i> Anterior dorso-lateral.
<i>ag.</i> Angular.	<i>p. d. l.</i> Posterior dorso-lateral.
<i>pt. m.</i> Postmedian.	<i>a. v. l.</i> Anterior ventro-lateral.
<i>p. m.</i> Premedian.	<i>p. v. l.</i> Posterior ventro-lateral.
<i>l.</i> Lateral.	<i>m. v.</i> Median ventral.
<i>e. l.</i> Extra-lateral.	<i>ar.</i> Articular of limb.
<i>mn.</i> Mental plates, the "Unter- kiefer" of Pander.	<i>a.</i> Anconaeal of limb.
<i>s. l.</i> Semilunar.	<i>c.</i> Central of limb.
<i>a. m. d.</i> Anterior median dorsal.	<i>m.</i> Marginal of limb.

PLATE I.

Fig. 1. Restored outline of *Pterichthys cornutus*, Ag., seen from the dorsal surface. The thin black lines in this and Figs. 2 and 3 denote the edges of the plates which are overlapped, and therefore concealed; the double dotted lines indicate the grooves occupied by the lateral canal-system.

Fig. 2. Restored outline of the same species seen from the ventral aspect.

Fig. 3. Restored outline of the same species, lateral aspect.

Fig. 4. Outline of extra-lateral plate of *Pterichthys*, natural size.

PLATE II.

Fig. 1. Outline of external surface of anterior median dorsal plate of *Asterolepis maximus*, Ag., sp., much reduced. The shaded area *x* is that overlapped by the front of the posterior median dorsal plate.

Fig. 2. Outline of the internal surface of the same plate; *x* and *y*, marginal areas overlapping the anterior and posterior dorso-lateral plates respectively.

Fig. 3. Outline of internal surface of anterior median dorsal plate of *Bothriolepis giganteus*, Traq.; *x*, area overlapping the anterior dorso-lateral.

Fig. 4. Restored outline of the dorsal aspect of *Bothriolepis hydrophilus*, Ag., sp., from specimens in the Edinburgh Museum. The overlapped edges of the plates are not given here, but the lateral-line grooves are shown by double dotted lines.

Fig. 5. Front of anterior ventro-lateral plates of *B. hydrophilus*; *s. l.*, the single plate representing the semilunars.

Fig. 6. Outlines of the bones of the head of *B. canadensis*, Whiteaves, from specimens in the Edinburgh Museum, except the plates filling the median opening, which are copied from Whiteaves.

Fig. 7. Anterior median dorsal plate of *Microbrachius Dickii*, Peach, sp., showing its articulation with the anterior dorso-laterals.

Fig. 8. Dorsal plates of the carapace of *Microbrachius Dickii* seen from the internal aspect; the outlines of the head and of one of the arms are likewise shown.

V. Homosteus, *Asmuss*, compared with *Coccosteus*, *Agassiz*.

By Dr R. H. TRAQUAIR, F.R.S., F.G.S. [Plate III.]

(Read 21st November 1888.)

The creature which forms the subject of the present communication is the same as that which was described as *Asterolepis* by Hugh Miller in his "Footprints of the Creator," and consequently its remains are at present better known to British geologists and palæontologists under that name. Why, then, alter a name which we have used so long? is a question likely to be asked by those who have not critically studied the complicated mesh in which the synonymy of the name "*Asterolepis*" is entangled.

The genus *Asterolepis* was proposed by Eichwald in 1840¹ for fragmentary remains of the exoskeleton of a vertebrate organism, from the Russian Devonian rocks, allied to *Pterichthys*, Ag. To these remains Agassiz also applied the name *Chelonichthys*, which he subsequently withdrew in favour of *Asterolepis* as having priority; and with them he also identified generically certain large bones and plates from the Lower Old Red of Dorpat, some of which were first figured by Kutorga² as "*Trionyx*" and "*Ichthyosauroides*," and of which a considerable number, collected by Asmuss, were reproduced in plaster and copies sent to Agassiz. A number of these casts were figured by Agassiz³ as bones of "*Asterolepis*," some of which are generically identical with the creature of whose bones and cranial buckler many fine specimens from Thurso, largely collected by Robert Dick, came into the possession of Hugh Miller. And thus it was that these remains came to be figured by Hugh Miller as belonging to *Asterolepis*, although they had no affinity to the creature to which Eichwald originally gave that name, their identification with which being entirely due to a

¹ "Die Thier- und Pflanzenreste des alten rothen Sandsteins und Bergkalks im Novgorodischen Gouvernement" (Bull. Acad. Imp. St Pétersburg, tome vii., p. 78).

² Beiträge zur Geognosie und Palæontologie Dorpats, 1835-37.

³ Poiss. Foss. du vieux Grès Rouge, tab. xxxii.

mistake of Agassiz, misled as he was by their mere external sculpture, consisting of small tubercles with stellate bases.

For, that "*Asterolepis*" cannot be applied to any of the remains from Dorpat represented by these casts, is unconsciously shown by Agassiz himself, inasmuch as he figured as "*Asterolepis ornata*," Eichwald, a nuchal or median occipital plate of unmistakable Pterichthyan character,¹ apparently quite unaware of the significance of its shape. Nevertheless Agassiz, in some controversial remarks on the subject, insisted that his *Chelonichthys* (= *Asterolepis*) had nothing to do with *Pterichthys*!²

Now, in 1856, Asmuss published a thesis³ in which he minutely described the Dorpat fossil bones, including the subjects of the aforesaid casts, and made out of them two genera, *Homosteus* and *Heterosteus*, with many species. In the former of these two, namely *Homosteus*, Hugh Miller's fish, the so-called "*Asterolepis* of Stromness," is clearly to be recognised.

Upon these facts Pander insists in his "Placodermen," and not only did he propose to replace "*Asterolepis*" by *Homosteus* in the case of Hugh Miller's fish, but believing *Asterolepis*, Eichw., to be altogether identical with *Pterichthys*, Agassiz, as the name is undoubtedly prior, he proceeded to cancel the latter name altogether.

Naturally Pander's views excited opposition in this country, where the names brought into use by Agassiz and Hugh Miller had become classic through the writings of these distinguished men. Sir Philip Egerton, who does not seem to me to have thoroughly understood the situation, fiercely combated the proposals of Pander in the following words: "Having read both sides of the question with great care, my own impression is that Prof. Eichwald may perhaps have included in his genus *Asterolepis* some fragments which he subsequently ascertained (through the more perfect Scotch specimens sent to Russia by Dr Hamel) to belong to

¹ *Op. cit.*, tab. xxx., figs. 5, 6.

² *Op. cit.*, appendix, p. 152.

³ Das vollkommenste Hautskelet der bisher bekannten Thierreiche, Dorpat, 1856.

the genus *Pterichthys* of Agassiz, and hence discarding the majority, namely, *Asterolepis* proper, assigns this name to the minority, to the exclusion of the Agassizian name. In the meantime Prof. Agassiz, then engaged upon his 'Poissons Fossiles du vieux Grès Rouge,' received through Prof. Brown, from Eichwald himself, specimens of his *Asterolepis*, which had no reference to *Pterichthys*, but were identical with the genus *Chelonichthys* established upon specimens brought over from Russia by Sir Roderick Murchison, and of which other specimens were found in the Orkney beds. On making this discovery, he at once relinquished his own name, *Chelonichthys*, and adopted *Asterolepis* of Eichwald. If now it is sought to supersede *Pterichthys* of Agassiz by *Asterolepis* of Eichwald, it is surely just that the term *Chelonichthys* should be retained for Eichwald's *rejectamenta*, rather than *Homosteus* of Asmuss, a name of much later date than that of Agassiz."¹

But whatever the specimens from the Orkney beds may have been, if any one will only compare Agassiz's own figure of *Asterolepis ornata*, Eichwald ("Old Red," tab. 30, fig. 5), with the plate No. 10 in Pander's restoration of the same species ("Placodermen," tab. 6, fig. 1), he will see that this specimen at least, far from having "no reference to *Pterichthys*," is the median occipital plate of a very closely allied form indeed. Without injustice to the memory of Sir Philip Egerton, to whom palæichthyological science is indebted for so much valuable work, it is clear that he had not sufficiently gone into this question at least, as the fact above noted was dwelt upon by Pander himself (*op. cit.*, p. 16).

On the Continent, however, the name *Homosteus*, Asm., has been adopted for Hugh Miller's fish, and reasons have also been found for maintaining *Pterichthys* and *Asterolepis* as distinct genera, in a supposed difference in the articulation of the arms. In the *Geological Magazine*² for this year I have shown that this supposed diagnostic mark is untenable, at the same time that I have sought to establish

¹ Quart. Journ. Geol. Soc., vol. xvi., 1859, p. 122.

² Notes on the Nomenclature of the Fishes of the Old Red Sandstone (Geol. Mag., Dec. III., vol. v., 1888, p. 508).

another on the mode of articulation of the anterior median dorsal plate.

But Agassiz's work, in which he classified "*Asterolepis*" among his "*Coelacanthi*," a group generally equal to the Cycliferous Crossopterygii of more recent times, was the means of drawing Hugh Miller into mistakes of much greater importance than mere nomenclature. Accordingly, as Pander pointed out, Miller attributed to his *Asterolepis* "the teeth of *Dendrodus* and the scales of *Glyptolepis*," and made a very formidable creature out of it, ten to thirteen feet in length; indeed, referring one of the large Russian plates (*Heterosteus*, Asmuss) to the same genus, he calculated a length of eighteen to twenty-three feet for the entire fish. And his non-recognition of the true affinities of the creature led also to other mistakes in the identification of bones, to which allusion will be made in due course.

By Asmuss *Homosteus* and *Heterosteus* were placed in a family by themselves, *Chelonichthyda*, in a somewhat heterogeneous group of "*Ganoidea loricata*," the other families herein included being Spatularida, Acipenserida, Coccosteida, Pterichthyda, and Cephalaspida. As regards *Homosteus*, though, as Pander remarks, it is wonderful how, without knowledge of Hugh Miller's drawings or description, he was able to fit together the isolated plates at his disposal, yet, unacquainted with the orbits, he supposed the cuirass to belong exclusively to the body, and also entirely reversed its position on the animal.

Pander, however, classified *Homosteus* in M'Coy's group of Placodermata, and rightly gave it a place immediately after *Coccosteus*, interpreting as its median dorsal plate the one considered by Hugh Miller to be a "hyoid," and supposed by him to occupy a place between the rami of the jaws. This supposed hyoid plate was known to Hugh Miller only in an isolated form, but it fell to the lot of the late Mr John Miller, of Thurso, to record a specimen in which it occurred in its natural position on the back behind the head, and so with absolute certainty to confirm Pander's view of the case. Mr John Miller's collection having some years ago passed into the possession of the Museum of Science and Art, Edin-

burgh, I propose to make this, the most perfect specimen of *Homosteus* which has ever been found, the text of the following remarks on the genus.

Along with *Homosteus* it may, however, be as well to re-examine the structure of *Coccosteus* itself as a basis of comparison.

The reading of the cranial buckler of *Coccosteus* is much complicated by the fact that certain superficial grooves belonging to the lateral-line system are very conspicuous and apt to be mistaken for sutures, while the true sutures are visible with difficulty, and can only be made out in exceptionally well-preserved examples. They seem, indeed, to have almost entirely escaped the observation of Agassiz, as the lines on the head indicated on his restoration of *Coccosteus* ("Old Red," tab. 6, fig. 4) belong almost without exception to the lateral-line system. The figures given by Hugh Miller (*Quart. Journ. Geol. Soc.*, 1859, p. 129, and "Footprints," 1st ed., fig. 11), in which he attempts to reduce the plates of the cephalic shield of *Coccosteus* to the same plan as that of the bones of the top of the head in the Cod, are much better, inasmuch as many of the true sutures are given; but it is also too plain that he also looked upon the superficial grooves as indicating the real boundaries of the plates which he considered as the homologues of the cranial roof-bones in osseous fishes. Pander's interpretation, although his figures give both sets of lines on the upper surface with considerable though not perfect accuracy, is correct only as regards the hinder part of the buckler, his reading of the anterior half being hopelessly wrong, and consequently his elaborate comparison with the arrangement in *Asterolepis* falls to the ground. By far the most correct restoration of the cranial shield of *Coccosteus* is that of Huxley,¹ in which he omits the superficial grooves altogether, and in which the only faults I can find are of omission, viz., the non-recognition of the median suture between the two central plates which he letters as "frontal," and of the pair of premaxillary bones on each side of that median bone in front, to which he applies the name "premaxilla."

¹ Dec. Geol. Survey, x., p. 30.

In Pl. III., Fig. 2, I have given a sketch of the head of *Coccosteus decipiens*, Ag., the superficial grooves being given in dotted, the sutures in continuous lines, and as regards the names I have applied to the bony plates, I have thought it best to use as few as possible which might lead the reader to infer that I considered them the morphological equivalents of the cranial bones of ordinary fishes.

Posteriorly we have the trapezoidal *median occipital* plate (*m. o.*), flanked on each side by the triangular *external occipital* (*e. o.*). In front of these are the two *central* plates (*c.*), external to which and forming the antero-external margin of the buckler are three plates, *marginal* (*m.*), *post-orbital* (*pt. o.*), and *pre-orbital* (*p. o.*), the two latter forming the upper margin of the orbit. The two pre-orbitals come together in the middle line posteriorly only for a very short distance, in front of which they are separated by a narrow oval space open anteriorly, and in this space is lodged, first a small elliptical plate, the *posterior ethmoidal* (*pt. e.*) and the median limb or stalk of the *anterior ethmoidal* (*a. e.*). This latter bone, the "pre-maxilla" of Huxley, is like a nail-head with a broken-off stalk attached, the head forming the anterior point of the buckler, the stalk passing back between the pre-orbitals. On each side of it in front are the small nasal openings (*n.*), each being bounded externally by a small separate bone, the *premaxilla* (*p. max.*). The orbit is bounded below by the "paddle-shaped" bone (see Fig. 3) representing the *marilla*, which has a sort of resemblance to that in *Palaemoniscus*, and to the posterior extremity of which is appended a small triangular plate (*pl.*), the *genal* or *post-maxillary*.

Turning now to *Homoniscus*, we shall find that Hugh Miller's comparison of its cranial plates with those of *Coccosteus* is not so far amiss, of course taking into account the facts of its reading of the buckler of the latter genus. In Fig. 1, I have sketched the configuration of the specimen of *Homoniscus* referred to by John Miller as having the dorsal plate *ex situ*. Much of the bony substance having splintered off from the "specimen" itself, I have had a plaster impression taken from the "counterpart" which consequently reproduces the details of the original in a very much more

perfect manner, and from this model the drawing has been taken. And I may add that every detail of the buckler here given is corroborated by another splendid specimen, also from the collection of John Miller, in which, however, the dorsal plate has got displaced to one side.

We find a wonderful correspondence in the arrangement of the bony plates, the differences appearing almost entirely due to the altered position of the eyes, and the assumption by the cranial shield of an antero-posteriorly elongated instead of a broadly hexagonal figure.

The *median occipital* (*m. o.*), preserving its trapezoidal shape, has become much elongated, as have also the *external occipitals* (*e. o.*), while the *centrals* (*c.*) have become much smaller in proportion, and have come to take part in the inner boundary of the orbit, more, however, on the upper than on the under aspect; they are also in contact in front with the *posterior ethmoidal* (*pt. e.*), the hinder angle of which is inserted in a notch between their anterior extremities. The *marginal* (*m.*), also much elongated, is easily recognised; but it is now alongside of, instead of in front of, the external occipital, and the *post-orbital* (*pt. o.*) and *pre-orbital* (*p. o.*) have altered their relation to the orbit in a strange fashion. Separating internally, so as to allow the central to come into the boundary of that opening, they have thrown out processes which unite externally, and so in *Homosteus* the orbits come to be entirely enclosed *within* the buckler, instead of being *outside* it, as in *Coccosteus*. The last plate to be noticed is the *anterior ethmoidal* (*a. e.*), which occupies a position at the front of the snout exactly as in *Coccosteus*, but no trace is seen either of the small pre-maxillary, or of the nasal openings of that genus.

The lateral-line system of grooves is sparingly developed on the cranial shield of *Homosteus*. On each side the lateral groove passes along the external occipital and the marginal on to the post-orbital, where it divides into two branches, one of which passes outwards and forwards to the margin of the shield, while the other passes backwards and inwards to be lost near the middle of the central plate. If we compare this arrangement with that in *Coccosteus* (Fig. 2), we shall see

that the plan is quite the same, although the extent of the groove-system is considerably diminished.

The facial bones of *Homosteus* are extremely difficult of determination, and I must frankly confess that I have come to no certain conclusions regarding them. In the specimen represented in Pl. III., Fig. 1, are three detached bones, A, B, and C, on each side of the anterior part of the cranium, by which B and C are also partly concealed, while on the right side the bone A is seen only in longitudinal section, having stood on edge to the bedding of the rock. When those bones are seen in connection with examples of the buckler, they always occur in the same order, and isolated specimens of all of them are also in the collection of the Edinburgh Museum.

The bone A is broadest behind the middle, narrowest at each end, especially the anterior one. In the specimen here figured it is seen from the internal aspect, having apparently got turned over; but other specimens show that on the external aspect near the middle it had a patch of the usual tuberculation, with a short lateral-line system groove. This bone is figured by Hugh Miller as "lateral cerebral plate," but as many specimens in the collection show that its position was immediately below the edge of the antero-lateral portion of the buckler external to the orbit, the groove on its surface being a continuation of the transverse branch on the post-orbital, it is clearly the homologue of the paddle-shaped bone or *maxilla* in *Coccosteus* (Fig. 3). If this be the case, then we may assume that the bone B, following and parallel to it, is the mandible; but no traces of teeth can be found on either, or, indeed, on any bone which it is safe to refer to *Homosteus*. Like the Sturgeon, it must have been edentulous.

The bone C is figured by Hugh Miller ("Footprints," fig. 45a) as a clavicle (here he meant what we now call post-clavical); but, of course, such an interpretation founded on its superficial resemblance to the post-clavical of a modern Teleostean is here negatived by its position. Hugh Miller noticed the tuberculation of the outer side of one of its extremities, but in accordance with his theory of its position in the animal,

he assumed this tuberculated portion to be its "head," or anterior extremity. The present specimen shows, however, that this extremity was posterior.

The last and crowning point of interest in the specimen represented in Pl. III., Fig. 1, is the exhibition of the dorsal cuirass *in situ*. Five plates are here seen, one median and two lateral, corresponding exactly to plates occupying a similar position in *Coccosteus*.

The median dorsal plate (*m. d.*) is so well known as Hugh Miller's supposed "hyoid," that it requires no further description, beyond the remark that its resemblance to that of *Coccosteus*, except in its short broad shape and the want of the posterior elongated peak, must be evident at the first glance. It is here shown in position, its broad margin being directed forwards, and lying parallel to the posterior margin of the cranium, from which it is here separated by a narrow gap, its obtuse point being free and posterior. Its lateral margins overlap on each side two other bones, of which the anterior one (*a. d. l.*) was figured by Hugh Miller as "non-descript latero-hyoidal plate," he being well aware of its relation to the median bone, though, in accordance with his theory of the latter, he reversed its position. Its relation to the skull was, however, correctly represented by Pander ("Placodermen," tab. 8, fig. 2*a.*). It consists of two parts, one flattened above, and applied anteriorly to the outer part of the posterior margin of the skull, by which as well as by the median plate it is overlapped, and another, narrower, forming a right angle to the flattened portion and running forwards a little way along the posterior part of the outer margin of the cranial buckler; in the angle between the two parts is a socket for articulation with a corresponding projection of the postero-external angle of the external occipital. Naturally Hugh Miller found himself at a loss to account for the presence of this socket. Different as the two bones are in shape, it is impossible not to recognise in this bone the homologue of the *anterior dorso-lateral* in *Coccosteus* (Fig. 3), though here the socket and peg have changed their positions on the bones concerned.

Behind this anterior dorso-lateral there exists in the speci-

men figured in Pl. III., Fig. 1, another and much smaller plate (*p. d. l.*) on each side, which has not previously been noticed. It needs no reasoning to perceive at once that this is the *posterior dorso-lateral* of *Coccosteus* (*p. d. l.*, Fig. 3).

It is curious that no undoubted remains of a ventral body-carapace like that of *Coccosteus* have occurred in connection with *Homosteus*; but, at the same time, I might mention that the plate ("Footprints," fig. 37) designated "palatal plate" by Hugh Miller, looks to me as if it might well be the anterior median ventral, so far as its shape is concerned, though its great size may be considered as somewhat against the supposition. At all events there is no evidence for referring it to the palate.

There are also several other bones figured by Hugh Miller, and contained in the Edinburgh Museum, which, from the way in which they occur, associated with other undoubted remains of *Homosteus*, clearly belong to the same fish, but whose position in the body I cannot speculate upon. These are the "operculum" ("Footprints," 5th edition, fig. 39), the very curious bone (*ib.*, fig. 43) spoken of by Hugh Miller as "shoulder (*i.e.*, coracoid?) plate;" his so-called "dermal bones" (*ib.*, fig. 44). What the bones *c* and *e* in fig. 46 of the "Footprints" are, I am also unable to determine.

But a number of the other remains figured in the "Footprints" as "*Asterolepis*" belong not to *Homosteus*, but to *Glyptolepis paucidens*, Ag., sp. These are the scales (figs. 26 and 27), the mandibles (figs. 32, 33, and 36), the sections of teeth (figs. 34 and 35); the bone *d* (fig. 46), which I look upon as the lower end of the clavicle; and the interspinous piece (fig. 48), which Hugh Miller figured as the "ischium of *Asterolepis*." The latter is indeed a very curious bone, and it is not at all remarkable that the author of the "Footprints" should have sought to identify it with the basal bone of a ventral fin constructed in teleostean fashion. Knowing that such a pelvic fin-element could hardly have existed in either *Homosteus* or *Glyptolepis*, the bone was long a puzzle to me, until one day I observed a very similar bone supporting the distal set of interspinous bones of the second dorsal fin in a specimen of *Glyptolepis leptopterus*, also in the

Hugh Miller Collection. A similar bone supporting three smaller interspinous elements was described and figured by Sir Philip Egerton in *Tristichopterus*.¹

As regards the *species* of *Homosteus*, which has been under consideration, no specific name was given to it by Hugh Miller. By Morris² it was catalogued as the "*Asterolepis Asmusii*" of Agassiz, but I know not on what ground. Certainly I can find no resemblance between the sculpture of the surface of the plates of *A. Asmusii*, as given in Agassiz's figures, and that which characterises the present fish in which the tubercles are small, sharply defined, with prominently stellate bases, and for the most part closely placed. Nor can it be identified with the species of *Homosteus* described by Asmuss from Dorpat, and so I would propose that for the future it be known as *Homosteus Milleri*.

EXPLANATION OF PLATE.

(In all the figures the same letters refer to the same things.)

m. o., median occipital. *e. o.*, external occipital. *m.*, marginal. *c.*, central. *pt. o.*, post-orbital. *p. o.*, pre-orbital. *pt. e.*, posterior ethmoidal. *a. e.*, anterior ethmoidal. *p. mx.*, premaxillary. *n.*, nasal opening. *m. d.*, median dorsal. *a. d. l.*, anterior dorso-lateral. *p. d. l.*, posterior dorso-lateral. *a. l.*, anterior lateral. *p. l.*, posterior lateral. *i. l.*, interlateral. *a. v. l.*, anterior ventro-lateral. *p. v. l.*, posterior ventro-lateral. *p. m. v.*, posterior median ventral. A, B, C, three facial plates lying below the margin, anteriorly of the cranial shield of *Homosteus*.

Fig. 1. Sketch of a specimen of *Homosteus Milleri*, Traq., in the John Miller Collection, Museum of Science and Art, Edinburgh.

Fig. 2. Restoration of the top of the head in *Coccosteus decipiens*, Ag. The dotted lines indicate the distribution of the grooves of the lateral-line system.

Fig. 3. Sketch of a specimen of *Coccosteus minor*, H. Miller, from Thurso, the vertebral column omitted. Hugh Miller Collection.

¹ Dec. Geol. Survey, vol. x., p. 52, plate 5.

² Catalogue British Fossils, p. 318.

VI. *On a Tract of modified Epithelium in the Embryo of Sepia.* By WILLIAM E. HOYLE, Esq., M.A.

(Read 16th January 1889.)

On examining recently a number of serial sections of embryos of *Sepia*, I was struck by the presence of certain peculiarly modified ectodermal cells, and as the presence of these has not, so far as I am aware, been hitherto recorded, I propose in the following paragraphs to give a brief notice of the appearances presented.

The cells form a trifid tract (fig. 1) situated towards the

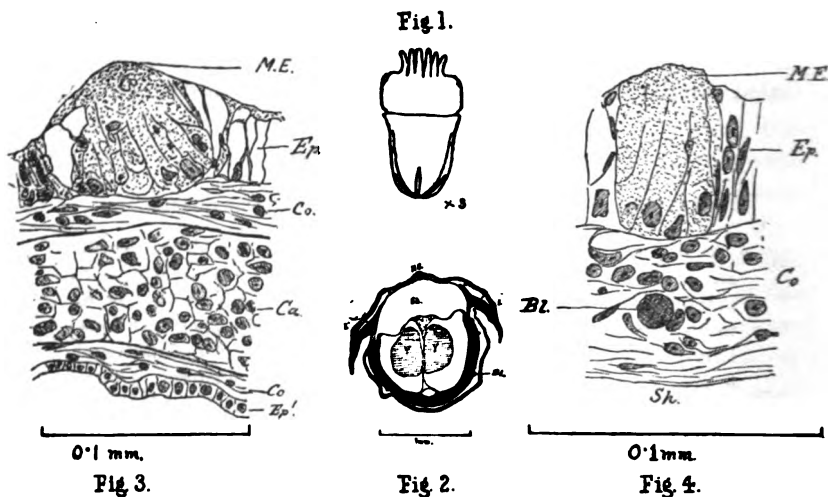


Fig. 1. Dorsal view of an embryo of *Sepia*, to show the three lines of modified epithelium.

Fig. 2. Transverse section of an embryo at about the same stage of development, to show the positions of the modified bands.

Fig. 3. Transverse section of one of the fins showing the lateral tract.

Fig. 4. Transverse section of the median tract.

Bl, blood vessels; Ca, cartilage, and probably muscles also of fin; Co, connective tissue; Ep, unaltered dorsal epithelium; Ep', epithelium of ventral surface of fin; L, lateral tracts of modified epithelium; M.E., median tract; Sh, cavity of the shell; Y, yolk masses.

posterior aspect of the body; the three branches of which lie, one in the middle dorsal line, and one on the dorsal surface of each fin, about midway between its origin and its

free margin (fig. 2, *m.e., l.*). The middle one extends somewhat farther forward than the other two, its anterior extremity being about on a level with the back of the ink sac. At their posterior ends the two branches which lie upon the fins pass on to the body, and unite with the remaining one in the dorsal median line.

These three ridges are clearly visible by the naked eye in embryos 5 to 8 mm. long, and appear to have been noticed by Kölliker, who figures them in his classic monograph on the "Embryology of the Cephalopoda."¹ He does not, however, appear to describe them in the text, but merely alludes to them in the explanation of the plates in the following words:—"Die Doppellinien sind Leistchen, die durch Hervorragungen der Schale bewirkt werden." It will abundantly appear from the sequel that this explanation is erroneous; there are no prominences on the shell of any kind, and furthermore two of the lines in question are situated not over the shell but on the fins.

When seen in section, each of the lateral branches (fig. 3) has the form of a more or less irregular ellipse, the length of the major axis depending upon the obliquity of the section. The cells of which it is composed are larger in all dimensions than those of the neighbouring epithelium, so that the level of the body-surface is slightly elevated where they are present. The breadth of the tract is about 0.1 mm., and the extreme elevation of the cells which compose it is about 0.075 mm. These are broader at the base than at the free extremities, so that the lines bounding them converge as they pass outwards. Their nuclei are spherical or slightly ovoid, and in almost all cases provided with nucleoli. They are situated almost exclusively near the bases of the cells, though in one or two cases I obtained evidences of their presence in the distal portions of the structure.

The contents of the cells are finely granular, and stain more deeply than those of the normal epithelium. The cell-boundaries become indefinite towards the superficies, and in some cases this part of the tract stains more deeply than the rest.

The medio-dorsal portion of the tract (fig. 4) is decidedly

¹ *Entwicklungsgeschichte der Cephalopoden*, Taf. iii., fig. 32.

narrower than the lateral portions, its transverse diameter not exceeding 0.05 mm.; in other respects it presented no variations worthy of notice.

I have observed the presence of a similar organ to that above described in sections of embryos of *Loligo* and *Ommastrephes*, but in them only the median portion was observed, no trace being discoverable of the lateral portions which extend over the fins. In the former genus the patch of modified cells was wider than in *Sepia*, and seemed to cover a considerable proportion of the posterior extremity of the embryo, whilst in *Ommastrephes* it was reduced to a mere conical plug.

With regard to the functions and morphological value of this organ but little can be said. The nature of the cells seems to forbid the hypothesis that it is sensory. If, as seems most likely, it be glandular, then arises the further query, What are the nature and properties of its secretion?

With respect to its homology there are only two structures known to me with which it can be compared. The first of these is the shell-gland, the second the invaginated gland described at the posterior extremity of *Sepiella*; and it must not be forgotten that these two may possibly be modifications of the same primitive apparatus. In this regard its extension on to the fins seems remarkable if not inexplicable. These questions and others which at once suggest themselves must be left in abeyance till we have further information as to the origin and ultimate fate of the cells above described.

In conclusion, I desire to express my indebtedness to Mrs H. L. Calder, for her kindness in making me the sections upon which these observations were made.

VII. *A Theory of the Parasitic Habit of the Cuckoo.* By
J. ARTHUR THOMSON, Esq., M.A., F.R.S.E.

(Read 19th December 1888.)

The parasitic habit of the cuckoo has for long been a familiar subject of popular interest and of scientific inquiry, Many mistaken observations and fallacious theories in regard

to it have had their short day. That the theory at present most current is altogether satisfactory, few will maintain; the following note is suggested as complementary.

I. *Facts*.—The general facts which have to be explained are familiar to the omniscient “every schoolboy;” some of the details of minor importance are still debated. The female cuckoo shirks the brooding sacrifice usually associated with bird maternity. But though “she is hardened against her young ones, as though they were not hers,” she is not “deprived of wisdom;” by an elaborate and well-executed trick she foists her several eggs at intervals of a few days into the successive nests of various birds, which are usually insectivorous and suited for the upbringing of the intruder. The foster parents, all unconscious of being fooled, hatch the cuckoo egg among their own. The nestling grows rapidly, and is a dog in the manger by birth. Greedy and jealous, he (the masculine pronoun is oftenest correct) soon asserts his monopoly of nest and food and care by the summary eviction of the rightful tenants, whether they be still passive in ovo or more awkwardly assertive as nestlings. The result is the success of the stronger.

II. *Theories*.—That the above is a curious instinct, all admit. To some it appears inscrutable, to others only a special instance of a universal method which favours selfishness. Or again, one naturalist finds sufficient explanation in certain anatomical conditions which render brooding inconvenient; but other birds with similar abdominal peculiarities duly discharge their natural duties. Another refers to the almost unique power the cuckoo has of retaining the eggs, instead of laying them as usual in rapid succession; but this by itself requires explanation, and is insufficient. Then I find disconnected hints of the view I wish to suggest, in reference by some to the great greed, by others to the preponderance of males. It is necessary, however, to pass to the theory which at present holds the field.

The Darwinian theory of the parasitic habit emphasises its advantages, and maintains its gradual establishment by the usual process of natural selection. What, then, are the alleged advantages of the habit? The illustrious Jenner, in

his classic paper on the subject, was the first, I believe, to point out the following. The bird has but a short time to stay in its breeding area, and much to do in that short time. "Nature," he says, "has a call upon it to produce a numerous progeny." Yet it is an advantage to migrate early, and thus the habit of leaving the eggs to a succession of other birds to incubate.

Darwin supposed the habit to crop up. Why it should, he did not inquire, but started from its occasional occurrence as in the American cuckoo. The result was an advantage to the parent, and also to the offspring. The former got away sooner, the latter were better cared for. Those that learned the trick prospered, those that didn't were eliminated, and in virtue of its natural or unnatural success the device passed from being exceptional to become universal, became in fact an inherited specific instinct. Commenting upon this, Mr Romanes, who has made a special study of the sphere of natural selection, says:—"We have here a sufficiently probable explanation of the *raison d'être* of this curious instinct; and whether it is the true reason or the only reason, we are justified in setting down the instinct to the creating influence of natural selection."

Objections.—Now, while admitting with deference the weight of such testimonies as the above, I wish to urge a few objections.

(a.) What started the habit? Natural selection can hardly "create." Is this one of Darwin's strictly accidental variations? Was it a mere happy freak on the part of the ancient progenitor of our European cuckoo? To be successful the trick must be played with some care. It is hardly on a par with the casual use made by a partridge of a pheasant's nest, or by a gull of an eider duck's. While allowing that in its beginnings there may have been many misses before the conditions of success were learned, one would like to know the prompting impulses.

(b.) Are these to be found in the *advantages*? Do not these appear somewhat remote—the accelerated migration, the robuster young? Then as to the first, it does not now seem at all evident why the bird should be in a hurry;

would not the necessity have been even less long ago? Food, Macgillivray says, remains abundant, and the climate which does not injure the young for two months longer could hardly incommode the parents. The individual advantage to the parent is certainly not very obvious so far as migration is concerned. Yet the advantage ought still to be apparent, for one of our greatest modern Darwinians says that natural selection must continually operate to conserve and retain what it has previously gained.

Is the advantage, then, for the offspring rather than for the parent? Did the original starters of the trick really have a careful forethought of the best for their offspring in sending them out to nurse? Does a memory of the comfort of its fostered youth remain with the adult as an impulse to do the like for its young in turn? It would be interesting to inquire what form the memory takes in the preponderant males. On the whole, does this not seem subtler than nature dreams of?

But again, if the trick be simply a freak, without any stated impulse behind it or near-at-hand advantage in front of it, is not the common difficulty of the combination of happy circumstances required to ensure incipient success unusually great? And does not the success of the plan involve the presupposition of that monopolising tendency of the young bird, which the theory gives no account of? Then the difficulty as to the inheritance of such a freak, especially with preponderant males, is certainly appreciable. Such a device must have something behind it, before it can be transmitted. In short, except the direct individual gain through saving of trouble and sacrifice, the advantages hardly seem by themselves capable of justifying the elaboration of the device into an instinct by natural selection.

(c.) Before passing from objections, I may also urge the increased difficulty raised when we consider the occurrence of the habit. It is not generic, that is to say it is not practised by all the species of *Cuculus*. It obtains in related genera, however. Did it arise in some common progenitor? But it also occurs, in varied degrees of perfectness, in the widely separated, starling-like cow-birds. There again, there-

fore, there must have been similar combinations of happy circumstances fostering the occasional into the constant.

III. *Suggestion.*—The theory which I have to suggest is, that no special theory is required. What I mean will become quite evident in the next few paragraphs.

(1.) The general character of the cuckoo is very significant Brehm describes it as a "discontented, ill-conditioned, passionate, in short decidedly unamiable bird." "The note itself and the manner in which it is emitted are typical of the bird's habits and character. The same abruptness, insatiability, eagerness, the same rage, are noticeable in its whole conduct." The cuckoos are notoriously unsocial, even in migration individualistic. They jealously guard their territorial "preserves," and verify, in many ways, the old myth that they are sparrow-hawks in disguise. The parasitic habit is consonant with their general character.

(2.) The species consist predominantly of males. The preponderance is probably about 5:1, though one observer makes it five times greater. In so male a species it is not surprising to find degenerate maternal instincts.

(3.) Reproduction and nutrition, all authorities declare, vary inversely. The love-impulses wane before those of hunger. Now there is no doubt that even among greedy birds the cuckoos hold a very high rank. They are remarkably insatiable, hungry, gluttonous. Even the anatomical conditions, asserted by some to be important—the swollen, low-set stomach, may have their influence in the cuckoo, which has certain other peculiarities, though the same conditions may be overcome in other birds which remain perfectly natural. I might also suggest that the habit of feeding so largely as cuckoos do on hairy caterpillars, whose indigestible hairs form a feltwork in the stomach, may also have its irritant, gizzard-fretting, dyspeptic influence. But I keep to the certain fact, and say that with so strong nutritive impulses, it is little wonder the reproductive emotions are degenerate. There is too much hunger and gluttony for the higher development of love.

(4.) The reproductive relations of the sexes are at a lower level than polygamy, or rather polyandry; the males and

females do not pair in the strict sense ; there is no keeping company, though the males are said to be passionate during the breeding season. Nor is the female in its adult state externally distinguishable from the male.

(5.) The reproductive organs of both sexes are very small for the size of the bird. There is said to be a diminished blood supply. Little wonder, then, that the reproductive emotions are in degree slightly developed. The sluggish parturition at intervals of six to eight days is also striking and significant.

(6.) The eggs are remarkably small. While the adult cuckoo is some four times the size of an adult skylark, the eggs are about the same size. The American cuckoo, which is only occasionally parasitic, lays full-sized eggs. I know that the size of the egg is not always proportionate to the size of the bird. I am not saying that it should be. But I do say that when a bird for constitutional reasons seems to require all it can for itself, then it will have less to spare for its reproductive sacrifice. To say that the small size of the cuckoo's egg is "an adaptation in order to deceive the small birds," seems to me to strain a theory to the breaking point. (I shall not discuss the minor fact of the frequent similarity between the colouring of the cuckoo's eggs and those of its deluded victims. Darwinians explain this also by natural selection, and speak of an inherited adaptation of egg-colour. It seems legitimate to suggest, that in ways yet unintelligible, the mother may be influenced during parturition by the sight of objects [*e.g.*, victim's eggs], which strongly impress her. But this is entirely subsidiary.)

(7.) It has been usual, in discussing beginnings, to take some cue from the young stages. It is noteworthy in this light to emphasise the jealous cruelty of the young form—a fit prophecy of the adult character. In the restlessness of rapid growth, the nestling expresses the constitution of the species in its selfish monopolising greed and insatiable appetite. Observations are recorded of the persistence of the cruel disposition into adolescence, though it usually wanes with the anatomical peculiarity of the back, not very long after birth. The young form at any rate exhibits the essential character of the species.

(8.) Some corroboration is obtained from the character of the American cuckoo. There seems no doubt that it is occasionally parasitic, and it is interesting to note that observers speak of its unnaturally careless indifference for the fate of its young. The character in fact is less markedly evil; the occasional parasitism is just as intelligible as the occasional "reversion" of our cuckoo to ancestral habits, to apparent affection, as well as observed incubation.

(9.) In the cow-birds, again, where the habit occurs in different species in different degrees of perfection (if the term be admissible), the character is strikingly immoral. In one species (*Molothrus cadius*), a nest may be simply stolen, or the rightful nestlings may be thrown out, or actual parasitism may occur as an exception. In *M. canariensis*, the eggs may be dropped on the bare ground, or fifteen to twenty from different parents may be lazily, and of course fatally, huddled together in one nest. (Two cuckoo eggs are sometimes found in one nest.) In *M. pecoris*, which is polygamous, the crime has been evolved, and the habit is that of our cuckoo, one egg being laid in each foster-nest. The important point is the general immorality and reproductive carelessness which in one species finds expression in an organised device.

Conclusion.—The general character of the birds, the un-social life, the selfish cruelty of the nestlings, and the lazy parasitic habit have a common basis in the constitution. The insatiable appetite, the small size of the reproductive organs, the smallness of the eggs, the sluggish parturition, the rapid growth of the young, the great preponderance of males, the absence of true pairing, the degeneration of maternal affection, are all correlated and largely explicable in terms of the fundamental contrast between nutrition and reproduction, between hunger and love. Similar unnatural or immoral instincts in other birds, in mammals, and even in the lower animals are explicable in similar terms. The existing theory being deficient as an account both of the origin and development of the parasitic instinct, the present constitutional theory is proposed as complementary. The parasitic habit is a natural outcrop of the general character or constitution, only one expression of a dominant diathesis.

Since coming to the above conclusions, I have had the pleasure of reading Prof. G. H. T. Eimer's recently published work on the "Origin of Species." According to Eimer variations are few in number, definite in character, and determined by the conditions of growth. This is a constitutional theory of evolution. I was much pleased to find as a minor point in this interesting and important work, a discussion of the cuckoo's instinct, which, in the main, harmonises with that which I have just sketched. The subject is both beautifully and fully dealt with, and I shall therefore conclude by summarising Eimer's position.

He briefly criticises the Darwinian explanation, which appears to him to involve too many happy combinations. He believes that what is inherited in the establishment of the habit, is not the device itself, which one can hardly believe, but the influence of the foster upbringing. He maintains, and I of course agree, that the ancestral cuckoo acted deliberately in the trick, and some of this deliberateness of device may still persist. The explanation of the unnatural habit he finds in the bird's whole character and mode of life. In this connection he emphasises (a) the vagabond, restless habit; (b) the looseness of the sex relations, strong in passion, weak in love; (c) the irregular and gluttonous nutrition considered in relation to reproductive stimulus; (d) the slow laying of the eggs, itself dependent upon nutrition, and pointing to physiological conditions which modify even the deeply rooted impulse and instinct to brood; (e) the degeneration of social instincts and the preponderance of egoism. The essential similarity of Eimer's views with mine, is interesting to myself, and possibly corroboratory to others.

WORKS REFERRED TO.

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ROMANES, G. J., Animal Intelligence, Int. Sci. Ser., London, 1886.

VIII. *Variation in the Plumage of the Common Rook*
(*Corvus frugilegus*, Linn.). By Professor DUNS, D.D.,
F.R.S.E.

(Read 20th March 1889.)

I had occasion recently to inquire into the seasonal changes of colour in the varying hare (*Lepus variabilis*), and to review the data which some think warrant the inference of identity with the Irish hare (*L. Hibernicus*), but which others hold to point to relationship with the common species (*L. timidus*)—a form subject to occasional white variation. More weight is given in the latter case to the colour element than to features which are both persistent and better marked. I refer to this with the view of indicating that such variations are of no value in determining family relationship. They have no meaning beyond the individual instance. The only question of interest raised by them relates to the cause of departure from the normal colour—a departure which is more frequent among birds than mammals. But my present object is not the explanation of the variation—it is only the statement of it as a fact common to the *Corvidæ*, and, chiefly, to one of the best known of the family—the Rook.

The bird now on the table belongs to Mr J. D. F. Gilchrist, M.A., one of my students. It was shot in 1888 about two miles north of Anstruther, Fife; probably a bird from the Rookery at Kilrenny. The colour is a bright dark brown, with here and there, as on the wing coverts, slight, almost doubtful, shades of black. The bill, legs, and claws are of the same hue. This as a variation colour is not, so far as I remember, common. I have a record of it in the Raven (*C. corax*), and a fine instance in a Skylark, in my possession.

For about six weeks in the beginning of this winter an interesting variety of rook was frequently seen in the gardens of Greenhill Place. It may be best described by saying that its colours were similar to those of the Grey Crow (*C. cornix*), only the head and body were black and

the wings and tail ashy-grey. The last time I saw it was about the end of December. About the same time, a rook with scapulars as brightly white as those of the Magpie (*Pica rustica*) might often be seen feeding on bits of meat, bread, etc., which the janitor of the New College is in the habit of throwing out in front of it, or into the patch of grass at the head of the Mound. White seems always to have been the commonest variant. In Brown's recent "Life of John Bunyan," there is an interesting reference to Thomas Archer, the rector of Houghton-Conquest, the parish next to Elstow. "The delightful old man kept a sort of *Chronicon mirabile* of the little rural world in which he spent his tranquil days—'Memorandum.—That in Anno 1625, on Bonion of Elstow clyminge of Rooks neasts in the Bery Wood ffound 3 Rookes in a neast, all white as milk, and not a black fether on them.'” The Bonion mentioned here was Thomas, father of the author of the "Pilgrim's Progress." In Pontippidan's "Natural History of Norway," the learned author says, under *Corvus*:—"In this country there are some, though few, that are white, and some half white, and half black" (1753). "A gentleman of this neighbourhood," says the author of "The Natural History of Selborne," "had two milk-white rooks in one nest. A booby of a carter finding them before they were able to fly, threw them down and destroyed them, to the great regret of the owner, who would have been glad to have preserved such a curiosity in his rookery. I saw the birds myself nailed against the end of the barn, and was surprised to find that their bills, legs, feet, and claws were milk-white" (1789). In Jardine and Jesse's Edition of Selborne, 1850, the following notes appear:—"The Common Rook seems to be more subject to white variation than its other British congeners. Species entirely white are not often seen, but individuals, with parts of the wings and tail pure white, occur in almost every rookery" (*Jardine*). "Mr Yarrell informs us that white, pied, and cream-coloured varieties of the rook occasionally occur" (*Jesse*). "Albino individuals," says Macgillivray, "sometimes occur either pure white, or more frequently yellowish-white or cream-coloured, with the bill

[illegible]

per cent. of the young rooks shot that season in the Wall-house Rookery were marked with white, for the most part on the throat or breast. Gamekeepers were struck with the white patches, generally on the head of common hares; mole-catchers had never before met with so many white, or cream-coloured, moles; and in early summer, common weasles were seen, which seemed as if they were undergoing a change of fur similar to that characteristic of their congeners, the stoats. (*Specimens were exhibited.*)

The only inference I venture to draw from the facts now mentioned, and the specimens now exhibited, is, that in seeking for an explanation of these random variations, some attention might be given to the influence of weather on the food supply for birds, though certainly not in the line of the folk rhyme—

“When there’s muckle snaw
There’s mony a haw.”

That, apart from weather, food itself is often the chief variant, is well known. If a tame bullfinch be fed chiefly on hemp seed, the plumage becomes at first dark-grey, then almost or entirely black. I show the skin of a wild bullfinch of this colour.

IX. *On some Wasps' Nests from South America.* By
Professor DUNS, D.D., F.R.S.E. (*Specimens exhibited.*)

(Read 20th March 1889.)

The nests of foreign *Vespidæ* present great variety both of shape, size, material, colour, arrangement of combs, entrance from the outside, and internal communications between the different tiers of combs. For the most part the walls are smooth, but in some they are rough, and in others knobbed all over. The first specimen now submitted to the Society is the nest of the earliest and best known of South American forms—*Chartergus nidulans*, Latreille; *Vespa nidulans*, Fabricius. This has been fully described by these entomologists, Cuvier, and others. It is formed of a smooth, solid, white substance resembling pasteboard, a material well fitted to

keep out the rain. The combs are not, as in our wasps' nests, suspended from the top and free all round. They are horizontal and fixed to the walls of the nest, and the entrance to the tiers is by a hole in the median line. The cells are hexagonal, and open downward on the lower or slightly convex side of the combs. The entrance to the nest is funnel-shaped, and so is it, though the funnel is less pronounced, in each layer of comb. The funnel is in the centre of a smooth lozenge-shaped space free of cells. This space gradually diminishes till it disappears in the topmost layer. The greater part of the nest is, in shape, like an inverted cone, on the upper part of which an inverted cup-like addition is placed, and by this it is suspended.

In 1841 Mr Adam White described, in the "Annals and Magazine of Natural History," a new genus of honey-storing wasp under the generic term *Myrapetra*—"a fanciful word," he tells us, "compounded of the names of two cities, one in Asia Minor, the other in Arabia"—a good illustration of the arbitrary if not mischievous ascription of meaningless terms to indicate new genera. Mr White describes the nest also of one species under this genus, *Myrapetra scutularis*. The nest now on the table was given to me by Dr H. Gunning, so well known by his recent munificent gifts in behalf of Scottish science. Its height is $12\frac{1}{2}$ inches, breadth $9\frac{1}{2}$ inches, circumference at bottom 33 inches, about the middle 32 inches, and near the top $17\frac{1}{2}$ inches. Looked at below, the base is horseshoe-shaped. There seems to be no doubt that the nest is that of one member of the genus *Myrapetra*, but it differs so much from the nest described by White as to warrant its ascription to a different species. This will best appear by setting the leading features of both in separate columns:—

Nest in British Museum.

1. Material, white pasteboard-like.
2. Viewed sideways, oblong.
3. From beneath, somewhat ovate.
4. Covered with conical knobs of various shapes.
5. Knobs in some instances $\frac{2}{3}$ of inch long.

Nest in New College.

1. Grey coloured, papery.
2. Circular, broad at base.
3. Horseshoe-shaped.
4. Many conical knobs of same shape.
5. Knobs all shorter.

Nest in British Museum.

6. Knobs run irregularly in transverse ridges.

7. Entrances intricately twisted (to prevent ingress of moths).

8. Substance, dried dung.

9. The different "stories," or tiers, of combs are attached to the common wall of the nest; the entrances to the compartments are at the sides, a small irregular-shaped space being left between the comb and the wall of the nest.

Nest in New College.

6. Knobs run regularly in ridges which follow the edges of the combs.

7. Entrances direct.

8. Substance same as that of British wasps.

9. The different "stories," or tiers, of comb are attached to the common wall, the entrance to the compartments being by one hole reaching from the bottom to the top, and at one side only; this entrance to the layers of comb is secured by the edges of the combs at the place not being attached to the nest wall.

In the vacant space thus left I found that a mason wasp had formed its nest. Two pupa cases were in the cells, from one of which the perfect form, shown in the small glass case, was taken. The other was left unopened, and is also shown.

X. Notes on a Collection of Birds and Eggs from the Republic of Paraguay. By J. J. DALGLEISH, Esq., M.B.O.U.

(Read 20th March 1889.)

The *Proceedings* of the Society contain some Notes¹ read by me upon two former occasions, descriptive of a collection of Birds and Eggs from Central Uruguay. My former correspondent there having some time ago left that country and settled in the neighbouring Republic of Paraguay, I am now enabled to make a few similar Notes upon a small collection lately received as a first instalment from that locality.

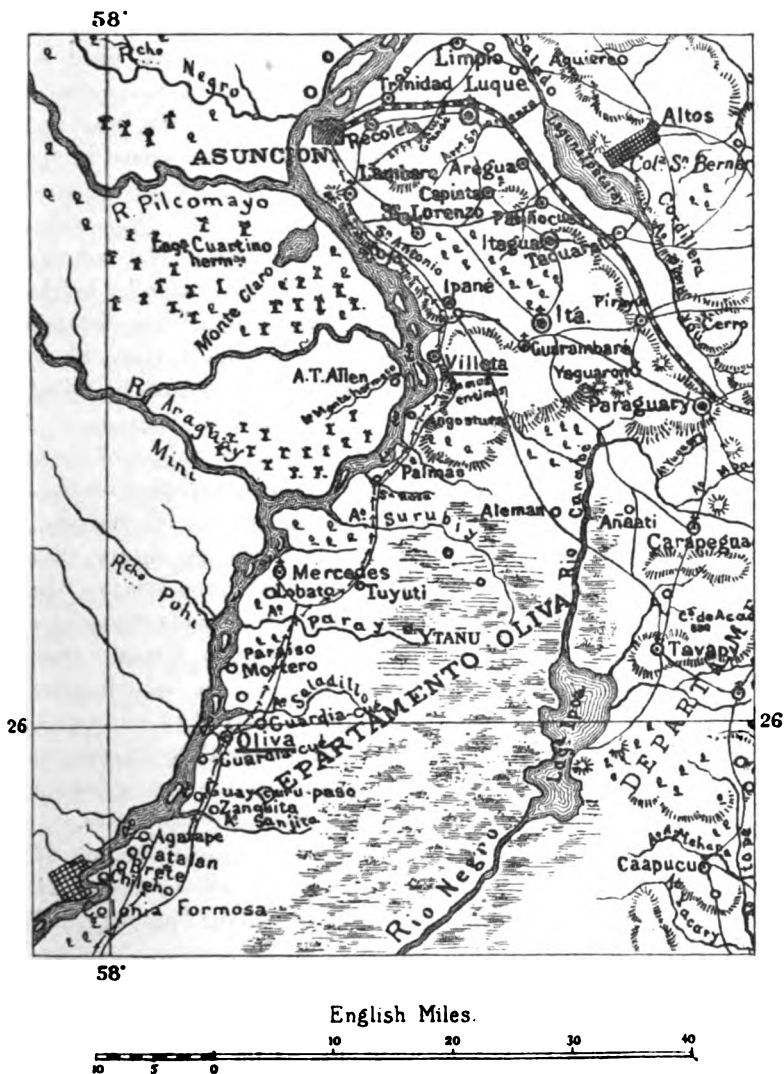
Paraguay, one of the most thriving of the Spanish Republics of South America, is situated, as is well known, between the river of that name and the River Parana, both tributaries of the great River Plate or Rio de la Plata. For some years prior to 1870 it was much desolated by the ravages of war, but is now fast recovering, and bids fair soon to rival in comparative prosperity, and as a field for immigration, its large and thriving neighbour, the Argentine Confederation.

¹ Vol. vi., 232; vol. viii., 77.

If much remains to be done for the ornithology of Uruguay, still more does Paraguay offer an almost untrodden field for the naturalist. Since the time of the Spanish traveller Azara, whose work, published between the years 1802 and 1805, contains merely the Spanish names of the birds, but is otherwise valuable, we have only the limited observations made by Page, a United States naval officer, who surveyed the Paraguay in 1857, and those of a German traveller named Rhode, whose investigations were chiefly of an ethnological nature. The results of Page's collections are to be found in scattered notices in scientific serials. Of those of Rhode, which were made from December 1885 to February 1886, a catalogue has been published by Count von Berlepsch in the *Journal für Ornithologie*, 1887, to which he has added a list of all the species hitherto recorded from Paraguay, including those in Azara's work so far as they have been identified, and numbering 357 in all.

The immediate locality from which the present collection has been sent is the Estancia of Ytañu, which is situated about 80 miles to the south of Asuncion, the capital, and on the bank of the River Parau, a tributary of the Paraguay, from which latter it is distant in a direct line about 12 miles. The Estancia has a river frontage of 12 miles, and the house stands 300 yards from the bank of the stream. The boundary touches at one point a large lake named the Laguna Ipoa, distant 9 miles. The Parau, which has its primary origin in Laguna Ipoa, flows out of a great swamp upwards of 6 miles wide, lying on the borders of the lake. It is very winding in its course, and from the point where it becomes a stream has a length of about 24 miles to its point of junction with the Paraguay. Opposite Ytañu the banks are somewhat raised, and the channel in dry weather is only about 20 yards wide, and from 3 to 5 feet in depth, with a sluggish and almost imperceptible current. Elsewhere the banks are lower and the stream wider and shallower. The ground being flat and level, the river during the rains often covers a width of from 500 to 600 yards. Laguna Ipoa is believed to be about 6 miles wide, and contains some small islands, but neither it nor the adjoining great swamp have

MAP OF PART OF PARAGUAY.



been fully explored. It is said to abound with fish of various species, and both it and the River Parau are frequented by numerous alligators. Before the desolating wars of Lopez there used to be a communication through the swamp to the towns beyond or to the east of the lake, but this is now impassable, the reeds and paca (a sort of coarse grass used for thatch) having grown up so thick, as well as a species of floating creeper, which grows from 12 to 15 yards long, and entangles the legs of a horse, endangering the safety of the rider. There is also considerable risk from the presence of large snakes in the swamps, which live on the frogs which there abound, and on the eggs of water fowl. The country surrounding Ytañu is flat, nor does it rise much in height until the eastern side of the lake is reached, a little distance beyond which it rises into mountains of some elevation, whose tops are visible from the Estancia at a distance of 20 miles. The immediate surroundings of the latter are possessed of some degree of natural beauty; clumps of palms of three different fan-leaved species, and of other varieties of trees varying in extent up to woods of some size, are intermingled with natural meadows or openings of a swampy nature, with abundance of good cattle grazing. The ground below the palms is open and grassy, but in the other woods there is a thick undergrowth of brushwood and thorny plants. Deer of two species, one of which is as large as the red deer and the other resembling the roe deer, are plentiful in the woods, coming out in early morning and at nightfall to browse on the short pasture. They are preyed on by the jaguar, which is still not uncommon, and at times destructive to cattle.

The nearest towns of importance are Villeta, distant 42 miles on the route to Asuncion, and Villa Oliva, distant 21 miles, both of which are situated on the River Paraguay, and appear in most maps.

In the Notes which follow I have not thought it necessary to repeat descriptions of the nesting habits of those species mentioned in my Notes on Uruguay. I have given to those species, which are common to both countries, the English names adopted by Selater and Hudson in their *Argentine Ornithology*. I have also, as formerly, given the native name

when known, and have added the name given by Azara, as identified in the useful *Systematic Index* of Hartlaub, published in 1847.

It will be observed that many of the nests are described as being placed in holes in palm trees; these, my correspondent informs me, are caused by the agency of the frequent forest fires which are common in that country, and are adapted by the various species to meet their requirements.

I am again much indebted to Dr Sclater for his kindness in identifying the species.

1. *Troglodytes furvus* (Gm.). Brown House Wren.—The nesting habits of this species have formerly been described from Uruguay.

2. *Embernagra platensis* (Gm.). Red-billed Ground Finch. Local name Corichore (*Habia de bañado. Azara*).—This bird is found throughout Southern Brazil, Uruguay, and Argentina. A ground-feeding species, it is usually met with in damp spots, notably where the Pampas grass flourishes, on whose sprays it is fond of perching. Hudson states that it is disappearing along with this plant in the Argentine Republic, before the advance of cultivation, contrary to the usual result in the case of seed-eating birds. Like many of the South American species it has little or no song.

A clutch of three eggs taken 30th November 1887 from a nest placed in a bunch of grass. These, with others from the Argentine Republic, average $1\frac{1}{8}$ by $\frac{3}{8}$ inch in size, and are of pyriform oval shape, and white in colour, spotted and streaked with very dark purple, chiefly at the large end. The egg is figured in D'Orbigny's work on South America (Plate 22).

The nest is formed of withered grasses and palm fibre, is slightly cup-shaped, measuring $4\frac{1}{2}$ inches across, and 3 inches over the opening.

3. *Cassicus albirostris* (Vieill.). Local name Guirangari (*Japa negro y amarillo. Azara*).—This genus of birds is remarkable for its curious pendulous nests. The present species is not common in collections, being seemingly of limited distribution. It is found in the provinces of Rio

Grande do Sul and San Paulo in Southern Brazil, whence it extends into Paraguay. Schomburgh records it from Guiana, but Sclater doubts much if it reaches so far north. It feeds on oranges and other fruits and seeds.

Clutch of two eggs taken 20th November 1887, measuring respectively 1 by $\frac{7}{8}$ and $\frac{7}{8}$ by $\frac{3}{8}$ inch. They are of an elongated oval shape, greyish-white in colour, closely freckled over with minute reddish-brown spots.

The nest, which was suspended from the extremity of a branch of a tree at a considerable height from the ground, is a long purse-like structure of a black vegetable fibre resembling horse hair, probably of some plant growing in the neighbourhood, the total length of which is 34 inches. The opening is placed about 18 inches from the upper end, from which the passage to the nest proper descends about 9 inches farther to the latter, which then opens up in the form of a circular bag of 5 inches in diameter, and $4\frac{1}{2}$ inches in depth, and in which the eggs are placed without lining. The nest is woven entirely by the bill of the bird, and my collector describes the observation of the process as most interesting, the bird permitting a close approach without alarm.

4. *Aphobus chopi* (Vieill.). Chopi Boat-tail. Local name Guirau (*El Chopi. Azara*).—The distribution of the Chopi seems confined to the central part of South America, where it inhabits Bolivia, the North-eastern part of the Argentine Republic, most of Brazil, and all Paraguay, in which latter it is quite common. A social species, it is generally found in flocks like the Starling, so large as to blacken the trees on which it alights. In Paraguay it is very destructive to the maize fields and to gardens, which require to be watched in consequence of its depredations. It is very sagacious, and gives warning to other species of the approach of birds of prey, which, although somewhat shy otherwise, it bullies with impunity. It frequents courts and verandahs of houses, and is often kept in captivity, being by no means an indifferent songster. Its nest is usually placed in a hollow tree, hole in a bank, crevice in a wall, or other similar situation, but is sometimes found in a thick tree or bush.

Clutch of five eggs taken on 10th November 1886 from

a nest placed in the tuft of a palm tree. Another clutch of four eggs taken 27th November 1886 from a nest placed in a hole in a palm tree.

These eggs average in size $1\frac{1}{6}$ by $\frac{3}{8}$ inch, the smallest being $\frac{3}{8}$ by $\frac{3}{8}$, and the largest $1\frac{3}{8}$ by $\frac{1}{2}$ inch. The first clutch varies greatly in size, while the other is nearly uniform. They are of a delicate pale blue colour, finely streaked with hair-like markings, and a few spots of very dark purple, chiefly round the larger end.

The nest is formed of the points of the palm leaves and twigs of climbers which run up the palm trees. The former are like flat grasses and are interwoven into a cup-like nest, which measures $4\frac{1}{2}$ inches across, with an opening of 3 inches, and is $1\frac{1}{2}$ inches in depth.

5. *Myiarchus tyrannulus* (Müll.). Rusty-tailed Tyrant. Local name Guira caballero (*Suiriri pardo y roxo. Azara*).—This Tyrant bird is found throughout South America down to the Argentine Republic. White found it within the latter in the provinces of Oran and Salta, where, he says, it takes the place of *Pitangus bellicosus*, and Barrow observed it at Concepcion on the Lower Uruguay. It is rather a solitary and silent bird, often found sitting by the sides of paths through brushwood.

Clutch of four eggs taken on 7th November 1886 from a nest in a hole in a palm tree. They are oval in shape, nearly uniform in size, averaging $\frac{3}{4}$ by $\frac{2}{3}$ inch, and are of a rich cream colour streaked longitudinally with greyish lilac and dark brown markings.

The lining of the nest which accompanied the eggs consisted of matted hair interspersed with small pieces of the cast skin of a serpent.

6. *Furnarius rufus*, Gm. Oven Bird. Local name Hornero (*Hornero. Azara*).—This fussy bird is as common in Paraguay as in Uruguay, and its nest is of the usual form, from which it derives its name.

7. *Phacellodomus ruber* (Vieill.). Red Thorn Bird. Local name Anumbi (*Anumbi roxo. Azara*).—This is a species of very retiring habits like our own hedge sparrow, although not so active in its movements. It is not uncommon, yet it

is not easily procured owing to its keeping to the centre of the bushes it frequents. It is never met with in large woods, but always in clumps of brushwood and similar situations.

Clutch of two eggs taken 28th November 1886, another of three eggs taken 15th October 1887, and a third of four eggs taken 13th November 1887. These are oval in shape, of a very light cream colour, and devoid of markings. They average in size 1 by $\frac{3}{4}$ inch.

The nest, like others of the family of Thorn birds, is composed of a great mass of twigs, formed with two chambers, and laid horizontally, the inner or nesting one being lined with hair, fine roots, and feathers. It is placed in a bush at the extremity of a branch about 6 feet from the ground.

8. *Xiphocolaptes major* (Vieill.). Chesnut Wood Hewer. Local name Ypecu (*Trepadore grande*. Azara).—This species, whose habits somewhat resemble those of our Creeper, is found in Bolivia, the hottest part of the Argentine Republic, and Paraguay. It is common in the forests of these regions, where it may be seen rapidly running up the clear stem of a tree to the top, and thence flying to the base of another to repeat the same performance. In this they are much aided by the stiff bristly feathers of the tail, and by their strong and sharply hooked claws.

Clutch of three eggs taken on 14th November 1887 from a nest in a hole in a tree, several feet from the ground; another of two eggs from a similar position, taken on 25th November. These are of a dull white colour, with a rough surface, the shell being coarse in the grain, and are of a blunted oval form. The largest measures $1\frac{3}{8}$ by $1\frac{3}{8}$ inches, and the smallest $1\frac{1}{8}$ by 1 inch. The nests contained no lining save a few fragments of the wood left in the process of excavation.

9. *Chrysophilus Cristatus* (Vieill.). Red Crested Woodpecker. The local name of this bird is also Ypecu, under which the various woodpeckers are known (*Carpintero verde negro*. Azara).—Its nest and eggs have already been described in my notes on Uruguay.

10. *Colaptes campestris* (Vieill.). Local name "Ypecu"

(*Carpintero campestre*. Azara).—This species, which inhabits Brazil, Bolivia, Northern Argentina, and Paraguay, is, although a woodpecker in form, seldom or ever found in woods, but generally in the open camps or plain, in the vicinity of ant-hills into which it digs with its powerful bill, thereafter devouring the inmates. Very frequently several pairs are found in the same vicinity, and a favourite perch is the summit of an ant-hill, off which they fly with a cry of alarm.

Clutch of three eggs taken 27th November 1886 from a hole in a palm tree, which contained no lining whatever. These average in size $1\frac{1}{4}\frac{2}{8}$ by $\frac{3}{4}\frac{0}{8}$ inch, are of an elongated oval form, and white in colour with a high polish similar to the usual woodpecker type.

11. *Crotophaga ani* (Linn.). Black Ani. Local name Ano. (*Anno*. Azara).—This bird, one of the cuckoo family, is found throughout South America east of the Andes, and down as far as the southern provinces of Brazil. It is also a native of some of the West India islands, as St Vincent, Grenada, and St Croix. It is plentiful on the Amazon, where Layard found it at Para, about the edge of the forest and in deserted gardens. It is usually found on open pasture ground, where they feed on the insects disturbed by the movements of the cattle. They also feed on fruit. They are very social birds, going in flocks of about twenty and sometimes in company with the next species. Their song or whistle is not unmusical. It is known by English residents in Brazil as the Black Parrot from a fancied resemblance in the bill to that of a parrot. Its call resembles that of the curlew.

Clutch of three eggs taken from a nest in a palm tree on 15th November 1886. These average $1\frac{1}{4}\frac{1}{8}$ by $\frac{3}{4}\frac{0}{8}$ inch, and are of a blue colour like the egg of the heron, but are coated over with a dull white calcareous covering similar to that on a cormorant's egg, but of a greatly finer texture, which is easily rubbed off.

The nest is a flat platform like that of a pigeon, with a slight cavity, and is formed of twigs and dried leaves. It measures 6 inches across, and is about 2 inches in thickness.

12. *Guira piririgua* (Vieill.). Guira cuckoo. Local name Piririta (*Piririgua*. Azara).—This species, whose curious blue eggs with their lace-like markings I have elsewhere described,¹ is common in the neighbourhood of Ytañu. Its domestic arrangements, which partake of the nature of the family to which it belongs, are somewhat mixed, it being by no means uncommon for several birds to lay their eggs in one nest, which are all incubated by one of their number. My collector has sent me ten eggs all taken from the same nest. It is frequently tamed, and makes a nice pet.

13. *Conurus nanday* (Desm.). Local name Ñenday (*Ñendai*. Azara).—This fine parrot is found in Bolivia, the north of Argentina, and Paraguay, where it is not rare. Like all the family it feeds chiefly on fruit, and is very fond of oranges. It is frequently kept as a cage bird, and becomes very tame. Although not found near Buenos Ayres, it is often taken there in cages, where it is considered a rarity and much esteemed. It is said that it cannot be taught to speak.

Clutch of four eggs taken from a nest in a hole in a palm tree, 13th November 1887. Another from a similar situation taken on 15th December in the same year. These average in size $1\frac{5}{16}$ by $\frac{7}{8}$ inch, and are of a blunt oval in form, white in colour, and with a slight polish.

The holes in which the eggs were found contained no lining.

14. *Conurus vittatus*, Shaw. Local name Cotorra (*Chiripepe*. Azara).—This species, whose principal habitat seems to be Brazil, is also common in Paraguay. It feeds on fruit, but is also extremely destructive to the maize fields. Like the preceding species it is frequently tamed, but differs from it in becoming an excellent talker. One which belonged to the son of my collector became much attached to him. On one occasion it was tempted to join a passing flock, and was given up as lost, but he returned all right at dusk for his evening meal.

Clutch of five eggs taken on 9th October, and another of the same number taken on 14th November, both in 1887. These average in size $\frac{7}{8}$ by $\frac{7}{8}$ inch, the largest being 1 by

¹ Proc. Roy. Phys. Soc. Ed., viii., 87.

$\frac{3}{8}$ inch, and the smallest $\frac{3}{16}$ by $\frac{3}{16}$ inch. They are of a dull white colour, and more rounded than those of the last species.

The nest is placed in a similar position to that of the last species, and is also devoid of lining.

15. *Bubo virginianus* (Gm.). Great Horned Owl. Local name Nacurutu (*Nacurutu. Azara*).—This fine owl, known to American naturalists under the subspecific name of *B. virginianus* var. *magellanicus*, has latterly been considered by British ornithologists as identical with the form prevailing throughout North America, and is generally distributed throughout both continents, from the Arctic circle to Cape Horn. Throughout so extensive an area it naturally varies a good deal in colouring, but the races thus developed must all be referred to one species, as in habits they do not vary. One of the most notable peculiarities of this bird is its cry, which partakes of shrieks and barks of the most unearthly nature, and which have always inspired the aborigines, where it is a denizen, with superstitious fears. In Paraguay it lives alike on birds, mice, rats, and snakes. In North America it is particularly destructive to poultry, its depredations, like that of the fox, being of course at night. It lays from two to six eggs.

Clutch of two eggs taken on 15th October 1887. They measure $2\frac{3}{16}$ by $1\frac{3}{16}$ and $2\frac{3}{16}$ by $1\frac{3}{8}$ inches respectively, and, like those of owls in general, of a dull, white colour, and rounded in form.

The nest, which was placed at the top of a high tree, was of large size, formed of sticks and lined with grass.

16. *Asturina pucherani*, Scl. and Salv. Local name Alcon.—This hawk is found in Bolivia, the Argentine Republic, and Paraguay. It is usually seen when sitting motionless on the tops of high trees. Its flight is heavy and flapping, partaking of that of the buzzard rather than the falcon. It is sluggish and fond of seclusion. Barrow states its partiality for the sides of streams, and that it feeds largely if not exclusively upon fish. It is also known to prey upon serpents, and in Paraguay, at all events, upon mice and small birds.

Clutch of two eggs taken on 20th October 1887, measuring respectively $2\frac{2}{8}$ by $1\frac{1}{8}$ and $1\frac{3}{8}$ by $1\frac{1}{8}$ inches. They are of a dingy white colour, blotched with dark purple-brown markings like those of the buzzard.

The nest was formed of small sticks lined with a few leaves, and was placed in a high tree.

17. *Tinnunculus cinnamominus*, Sw. Cinnamomeous Kestrel. Local name Alcon para (*Cernicalo. Azara*).—This small kestrel, formerly recorded from Uruguay, is also found at Ytañu.

18. *Cathartes aura* (Linn.). Turkey Buzzard. (*Acabirdi. Azara*).—The Turkey buzzard is almost as extended in its distribution as the great horned owl. It extends throughout almost all North America south of the Saskatchewan River, and all South America to Patagonia. It is found in the larger West India islands, and is very numerous in the Falklands. A most useful bird in warm countries, where it acts as a scavenger; it feeds on carrion and all sorts of animal food, including fish. A specimen sent home by my collector was found to contain a fish in its crop when being skinned. It inhabits the cities of the Southern States of North America, but elsewhere is generally found in rural districts. Its sense of smell and sight are very keen. It lays two, rarely three, eggs. Its egg is figured in D'Orbigny's work.

Clutch of two eggs taken on 12th November 1887. They measure $2\frac{2}{8}$ by $1\frac{1}{8}$ and $2\frac{1}{8}$ by $1\frac{1}{8}$ inches respectively. The ground colour is white, much mottled over, especially at the base, in an irregular way with rusty brown. The mottlings in one are much smaller than in the other.

They were placed on the bare ground at the foot of a large tree.

19. *Cathartes atratus* (Bartr.). Black Vulture. Local name "Gabilan" (*Iribu. Azara*).—This species, found in Uruguay, is also common in Paraguay, where it is equally useful in clearing the camps of dead animals. Their eggs are frequently eaten by serpents and lizards. One of two sent me bears evidence of the visit to the nest of one or other of these reptiles.

20. *Ardea sibilatrix*, Temm. Whistling Heron. Local name "Curabiminbe" (*Flauta del sol. Azara*).—This handsome small heron is mostly confined to Brazil, Northern Argentina, and Paraguay, but has of late been found at Angostura, in Venezuela, and at Concepcion, on the Uruguay River, which has extended its known range considerably. In the latter locality, Barrow found it by no means common, but where he describes its habits as shy and solitary, active by day if disturbed, and as having a more rapid flight than any other heron of his acquaintance, flying away from the streams to dry woods and sandhills when thus alarmed.

Two eggs, taken on 4th November 1887, measure $1\frac{3}{4}$ by $1\frac{1}{8}$ and $1\frac{3}{8}$ by $1\frac{1}{8}$ inches respectively. They are round in form, and of a light, brownish-green colour, speckled over with a few minute spots of reddish-purple, thus differing a good deal from the usual type of heron's egg.

The nest was formed of sticks, and contained no lining; it was situated at the top of a large tree.

21. *Chauna chavaria* (Linn.). Crested Screamer. Local name "Chaha" (*Chaja. Azara*).—The Chaha, so named from its noisy call, is a large, fine, and somewhat striking bird, especially if seen in a flock. It is found throughout Southern Brazil, Paraguay, and Argentina. It frequents swampy ground, and can swim, but is usually seen wading when in the water. It is of powerful flight although so heavy a bird, and is described as soaring in spirals like an eagle, at times to so great a height that its presence is only detected by its cry. It possesses a large number of air cells between the skin and the lining membrane of the body, which it can inflate at will and thus enable it to soar at pleasure. It possesses, in common with some other birds, a curious and powerful weapon in the form of a spur upon the extremity of the wing bone, which enables it when wounded to defend itself with some success, and a young one unable to fly can with it beat off a dog. It is resident and very common in Paraguay, and is occasionally found tame about country houses, where, by its loud call on the approach of a stranger, it forms a good watch. Its flesh is said by Barrow to be hardly inferior to that of turkey. Its breeding

habits are irregular, nests being occasionally found in July and August. It lays from four to six eggs.

Three eggs taken from the nest on 20th December 1887, one of an elongated, oval form, and a dull, white colour; they average $3\frac{1}{4}$ by $2\frac{1}{8}$ inches in size.

The nest was placed at the side of the river, was formed of grasses, and slightly hollowed on the top.

22. *Chamæpelia talpacoti* (Temm.). Talpacoti Dove. Local name "Teruti del Monte" (*Paloma roxiza*. Azara).—This beautiful little dove is found throughout British Guiana, Brazil, Bolivia, the northern part of Argentina, and Paraguay, and is in some parts of the first-named country very plentiful and much esteemed for the pot. In Paraguay it is not so common, and is found either in pairs or in small flocks. It is occasionally kept in confinement.

Two clutches of two eggs each, both taken on 20th November 1886. These vary in size from 1 by $\frac{1}{2}$ to $\frac{1}{2}$ by $\frac{1}{2}$ inch, and are oval, white in colour, and of the ordinary pigeon type and appearance.

Both nests were placed near the top of a low palm tree, and were formed of withered grasses and fine roots, and were slightly hollow in the centre. One sent measures 4 inches over top.

23. *Rallus maculatus*, Bodd. Spotted Rail. Local name "Nahaná" (*Jaspeado todo*. Azara).—The spotted rail is found in Guiana, New Granada, Brazil, Paraguay, and the Argentine Republic. It also occurs in the island of Cuba. It is common in suitable localities where there are arroyos or lagunas. It makes its nest among reeds about 18 inches above the water. It usually lays up to seven eggs, but fifteen from one nest have been recorded, probably however the produce of more than one bird.

Clutch of five eggs taken on 12th November 1887, another of the same number taken on the 30th of the same month. These average in size $1\frac{1}{2}$ by $1\frac{1}{8}$ inches. Both clutches are of a rich cream colour, one being of a darker shade than the other; the latter has a few minute reddish-brown spots chiefly at the larger end, the former is lighter in ground colour, with larger spots of the same, and also a few faint

greyish lilac markings appearing as if below the outer shell ; the markings on one of the dark set, however, approach closely to those of the lighter coloured one.

24. *Aramides ypecaha* (Vieill.). Ypecaha Rail. Local name "Pacaa" (*Ipacahá. Azara*).—This bird is found generally in reed beds, coming out in the mornings and evenings to feed. It is found throughout Southern Brazil, Paraguay, and Northern Argentina. About the size of a barn door hen, it bears some resemblance to that bird in manners and appearance. When alarmed it goes off like a hen, with a run breaking ultimately into flight in the same manner as the domesticated bird. It is occasionally kept tame, and my collector saw one going with the poultry in the court of a hotel in Asuncion. It is a shy bird and not easily obtained.

Two clutches of five eggs each taken on 10th November 1886 and 9th October 1887 respectively. These vary a good deal in size, but average $2\frac{1}{8}$ by $1\frac{3}{4}$ inches. They are similar in colour to the lighter-coloured clutch of the last-mentioned species, and the markings, which are larger in proportion to the size of the egg, may also be described as similar in colour and character.

The nest was merely a scraped hollow in the centre of a raised bunch of grass.

25. *Parra jacana* (Linn.). The Jacana. Local name "Aguapeaso," literally "walker upon water" (*Aguapeazo. Azara*).—The Jacana is found throughout central South America from Guiana to Southern Brazil. It is very common on the Amazon. Essentially a water bird it is found on the rivers and larger lagunas, where, with its broadly extended toes, it easily walks over the floating plants on their surface, which harbour the insects upon which it feeds. Like our own water hen it is a slow and awkward flier, trailing its legs behind in flight. In habits it is shy, keeping well out from the shores of the lakes and rivers it frequents. Its food is minute mollusca and water insects. Its handsome egg is figured in De la Sagra's *Birds of Cuba*.

Clutch of four eggs taken 18th October 1886. Like other species of the same family these are very beautiful, being

of a brownish-yellow, ground colour, minutely grained over with black veins resembling pieces of rare and highly polished cabinet wood. They are very equal in size, averaging $1\frac{3}{8}$ by $\frac{3}{8}$ inch. They were laid without any nest on some floating leaves in the river.

26. *Vanellus cayennensis* (Gm.). Cayenne Lapwing. Local name Terutero (*Terutero. Azara*).—This plover is common at Ytañu and increasing there in numbers.

27. *Gallinago paraguaiæ* (Vieill.). Paraguay Snipe (*Becasina. Azara*).—This snipe is closely allied to *G. frenata* of my Uruguay list, and the eggs and situation of nest are very similar to those of that species, and of the common European snipe, *G. caelestis*.

Three clutches of eggs of three each, the usual number laid by this bird, taken on 6th and 30th November and 10th December 1887 respectively, average $1\frac{1}{8}$ by $1\frac{1}{8}$ inches in size.

28. *Rhynchotus rufescens* (Temm.). Great Tinamou. Local name "Ynanbuguaru" (*Inambu guazu. Azara*).—This tinamou has already appeared in my list of birds of Uruguay. In Paraguay, however, they seem to lay more eggs, ten having been sent me from one nest, while four is the usual number in Uruguay.

XI. Additional Notes on some British Carboniferous Lycopods.

By R. KIDSTON, F.R.S.E., F.G.S. [Plate IV.]

(Read 20th March 1889.)

The present paper must be regarded as an appendix to that published by me in the *Ann. and Mag. Nat. Hist.* in 1885.¹ Since that communication was written several important works dealing with the Carboniferous Flora have appeared, which contain additional information regarding the Carboniferous Lycopods. I have also continued my investigations on this subject, and now wish to lay before this Society some of the results. These are partly

¹ "On the Relationship of *Ulodendron*, L. & H., to *Lepidodendron*, Sternb., *Bothrodendron*, L. & H., *Sigillaria*, Brongn., and *Rhytidodendron*, Boulay," vol. xvi., pp. 123-139, 162-179, 239-260, pls. iii.-vii.

confirmative of the views I previously stated and partly correcting errors into which I had fallen.

I. *Lepidodendron Veltheimianum*, Sternb.

A few months ago I received for examination from the Geological Survey of England an impression of *Lepidodendron Veltheimianum*, collected by Mr Rhodes, one of their fossil collectors, from the Lower Carboniferous of Lumby Law Railway-cutting, a quarter of a mile north of Edlingham Church, Northumberland. It was contained in an iron-stained sandstone, and showed on the surface of the impression the leaf-scars and one of the large cone-scars. Attached to this latter is the basal portion of the appendicular organ, which had been imbedded in the matrix, and from the fortunate manner in which the block containing the specimen has split, one side of the appendicular organ is exposed. It is directed upwards and therefore similar in position to that of all the other specimens of the plant, which have shown the appendicular organ *in situ*. Owing to the rough nature of the matrix the minute structural points of this organ are not shown; but the impression of the fossil is sufficiently well preserved to enable a satisfactory identification of the species to be made, and, further, to confirm the opinion, that the organ in question is a cone.

My thanks are due to Dr A. Geikie for the opportunity of examining this fossil, which is contained in the collection of the Geological Survey of England.

I was previously of opinion that *L. Veltheimianum*, in addition to bearing lateral cones, which produced the large Ulodendroid scars, might also have produced terminal cones. Continued investigations have, however, led me to relinquish this view, as the cones, which I formerly believed to be the terminal cones of *L. Veltheimianum*, I have now seen attached to their parent branches, showing that they belong to an altogether distinct and, I believe, an undescribed species.

Note.—I wish to correct an error in the description of the

leaf-scar of *Lepidodendron*, which I made in the paper already referred to. In my previous communication it was stated on p. 173, "Leaf-base attached to the whole area of the leaf-scar (including the 'field')." That portion of the leaf-scar which is known as the "field" really belongs to the cortical system, of which it is in fact a cushion-like elevation. The true leaf-scar is only the small shield-like disk, which bears the vascular and the two lateral cicatricules. These two "lateral cicatricules" have no connection with the vascular system, and are probably glandular.

II. SIGILLARIA.

In my previous memoir I placed in *Sigillaria*, under the name of *Sigillaria discophora*, König, sp., the plant originally figured by König as *Lepidodendron discophorum*.¹ This is identical with Lindley and Hutton's *Ulodendron minus*.² My reason for placing this plant in *Sigillaria* was the structure of the leaf-scar, which I stated on p. 178 (*l. c.*) possessed, as had been figured by Sir William Dawson, a central and two lateral cicatricules;³ and though I had not observed them personally, I had no reason to doubt the accuracy of this writer's observation. In reviewing my paper, Mons. Zeiller⁴ gives his reasons for doubting the accuracy of the figure given by Dawson, in which the three cicatricules were shown, especially founding his opinion on the fact that Dawson states in the description of his species—*Lepidophloios parvus* = *S. discophora*—that the vascular points are obscure.

I received, however, in 1886 from the Rev. David Landsborough, Kilnarnock, to whom I am indebted for many

¹ König, *Icones fossilium sectiles*, pl. xvi., fig. 194.

² I should say here that although this latter name is the older one, it has been so much confused by authors, expediency almost demands that it be subordinated to the name given by König, from the use of which no confusion or misunderstanding can arise.

³ "Acadian Geology," 2d ed. 1868, p. 455, fig. clxx., G².

⁴ "Présentation d'une brochure de M. Kidston sur les *Ulodendron* et observations sur les Genres *Ulodendron* et *Bothrodendron*," Bull. de la Soc. Géol. de France, 3^e sér., vol. xvi., p. 168 (1885).

instructive specimens of our Carboniferous Lycopods, a fragment of a large specimen of *S. discophora*, which was unfortunately broken into several pieces, when removing it from the roof of the Whistler Seam, Kilmarnock. This example shows clearly the central and two lateral cicatricules of the leaf-scar. A small portion of the specimen is shown in PL IV., figs. 1, 1a. This specimen conclusively proves that the leaf-scars of *S. discophora*, König, sp. (= *U. minus*, L. & H.), are provided with three cicatricules very similar to those of *Sigillaria*, in which genus I believe the plant under discussion should be placed. It is very remarkable, that in such a common British Coal-measure fossil the true outer surface of the bark, showing the leaf-scars in a good state of preservation, is so seldom met with. One reason for this is the persistence of the leaves, which appear to have retained their attachment to the stem much longer than in the other Coal-measure Lycopods, and it is not uncommon to find the leaf-scars on stems of large specimens of *S. discophora* entirely obliterated by the foliage of the plant being closely adpressed to the bark.

I united *U. majus* and *U. minus*, L. & H.; but M. Zeiller regards them as distinct species, and has since figured a specimen which he believes to be the *U. majus* of Lindley and Hutton,¹ with which he unites *S. (Lepidodendron) discophora*, König. From the examination of a plaster cast of König's original specimen, which is still preserved in the collection of the British Museum, I feel quite satisfied that König's plant is beyond all doubt referable to *U. minus*, L. & H., and not to their *U. majus*, whatever may be the claims of *U. majus*, L. & H., to rank as a species. The size of the Ulodendroid scars or of the leaf-scars is of no specific value, and I have specimens of *S. discophora* in my own collection with Ulodendroid scars ranging up to 5½ inches in their greater diameter. There is no Ulodendroid scar on the specimen of *U. majus* figured by Zeiller; of course this does not prove that his specimen does not belong to that species, but as the case stands, I at present

¹ "Flore fossile du bassin houiller de Valenciennes," p. 481, pl. lxxiii., fig. 1.

believe that *U. majus*, L. & H., and *U. minus*, L. & H., are different ages and conditions of one species. I also feel certain, that *S. Menardi*, Lesqx. (not Brongn.),¹ which Zeiller unites with *U. majus*, is likewise referable to *S. discophora* (= *U. minus*, L. & H.). The type of *U. majus* appears to be lost, but the counterpart of the type of *U. minus* is still preserved in the Hutton Collection, Newcastle-on-Tyne, and on the careful examination of this, my identifications have been made.

III. BOTHRODENDRON, L. & H.

Bothrodendron, L. & H., Fossil Flora, vol. ii., p. 1 (1833).

Rhytidodendron, Boulay, Le terrain houiller du nord de la France et ses végétaux fossiles, p. 39 (1876, Lille).

In 1885 I recorded the occurrence of *Rhytidodendron minutifolium*, Boulay, from Scotland, and regarded the genus as distinct from all others; but to M. Zeiller we are indebted for showing that *Rhytidodendron*, Boulay, is none other than *Bothrodendron*, L. & H. To the defective descriptions of Lindley and Hutton must be ascribed the cause of this genus being so imperfectly known; and had it not been for the discovery of an original specimen, communicated by Hutton to the Museum of Natural History, Paris, the cloud that enveloped this genus might have hung over it much longer.²

In M. Zeiller's memoir, to which I have already referred, he figures stems and branches of *Bothrodendron punctatum*, the latter having their foliage attached. Recently I have met with specimens of *B. punctatum* as also with additional examples of *B. minutifolium* in Britain. The latter species I have found in several new localities, and it is represented by stems and branches with their foliage attached. *B. punctatum* I have only yet seen from the Kilmarnock Coal-field, and for specimens of it I am again indebted to the Rev. D. Landsborough and to Mr Blackwood, Kilmarnock.

¹ Geol. Survey of Illinois, ii., pl. xliii.

² I am greatly indebted to M. Zeiller for figuring at my request the authentic specimen of *Bothrodendron punctatum*, L. & H., which had been presented to the Muséum d'histoire naturelle by Hutton, and to which reference has been made (Zeiller, l. c., pl. viii., fig. 1).

The leaf-scars in this genus are very small and provided with three punctiform cicatricules. On the young growing branches the leaf-scars of some of the species are close and surrounded by a *Lepidodendroid*-like "field," but this entirely disappears on the larger stems where the leaf-scars are distant; the surface of the bark between the leaf-scars is beautifully ornamented by delicate lines and granulations.

In *B. punctatum* the fruit has evidently been borne in lateral cones, from which originate the two vertical rows of large Ulodendroid scars; and one marked feature which distinguishes the large scars of *Bothrodendron* from those of the other Ulodendroid Lycopods is, that in *Bothrodendron* the umbilicus of the large scar is eccentric, whereas in the Ulodendroid *Sigillariæ* and *Lepidodendra* the umbilicus is central or approximately so.

In *B. minutifolium*, Boulay, sp., the fruit is borne in long narrow cones at the terminations of the branches. The only specimen of the fruit of this genus which I have yet seen was collected by Mr W. Henningway at Monkton Main Colliery, near Barnsley, Yorkshire, in shale over the "Barnsley Thick Coal." This specimen he has kindly forwarded to me for examination. The cone is attached to a stem, which still bears the foliage of the species. Unfortunately the cone is imperfect in its upper part, so its full length cannot be determined. The portion preserved is $3\frac{1}{2}$ inches long, and at its thickest part rather over $\frac{1}{2}$ inch wide. The central axis in the compressed cone is seen to give off at right angles a number of transverse bars, which probably represent the basal portions of the bracts, that bore the sporangia. Their leafy extension rises up at almost right angles to their basal portion, and is therefore nearly parallel with the axis. These bracts are closely placed, as many as eleven being contained on the axis in the space of half an inch. The specimen is shown nat. size in Pl. IV., fig. 6.

I have received a very interesting specimen of a portion of a stem of *B. minutifolium* from Mr Landsborough. The lower part of this specimen is decorticated, and shows the

subepidermal leaf-scars. These are not simple as supposed,¹ but when well preserved are seen to consist of two linear elongated elevations, which are frequently connected in the centre, as shown in figs. 5 and 5*b*. They are very similar to those of *Sigillaria*.

The foliage of *B. minutifolium* and *punctatum* is very small, and the ultimate ramifications of the dichotomously divided branches have great similarity to those of recent Lycopods, as has been pointed out by Zeiller. Their systematic position is, however, probably intermediate between *Lepidodendron* and *Sigillaria*.

The genus *Bothrodendron* is not, however, restricted to the Coal-measures, for I have received from various localities in the Calciferous-Sandstone series specimens of a species of this genus, which I here describe.

Bothrodendron Wiikianum, Kidston, n. sp.
(Pl. IV., figs. 2-4.)

Cf. *Lepidodendron Wiikianum*, Heer, Foss. Flora d. Bären Insel, p. 40,
pl. vii., fig. 1 c; pl. viii., fig. 2 c; pl. ix., fig. 1.

Description.—Leaf-scars distant, small, varying in size according to the age of the branch, transversely oval. Cicatricles three, punctiform, situated towards the lower margin of the scar. Above the leaf-scar is a small punctiform cicatricule. Surface of the bark between the leaf-scars irregularly striated longitudinally, the striæ bending round the scars and leaving in their immediate neighbourhood a smooth space:

Remarks.—The leaf-scars vary in size and distance apart according to the age of the specimen. In my smallest example they are about 1 millim., and in the largest specimen 3·5 millim. in transverse diameter. On the young branches the little punctiform cicatricule is immediately above the leaf-scar, and seems to rest upon it; but in the largest specimen of the species, that I have seen, it is separated from the leaf-scar by a short distance.

The bark is longitudinally striated, the striæ being slightly

¹ Zeiller, l. c., p. 181.

bent, especially in the neighbourhood of the leaf-scars round which they curve, and immediately below and above the leaf-scars they are absent, having the appearance as if they had separated to make room for the scars. There is, however, no "field," as in *Lepidodendron*.

I have named this species "*Wiikianum*," as there seems to be a great probability that this plant is similar to Heer's *Lepidodendron Wiikianum*, from Bear Island.¹ The British specimens are not, however, referable to the genus *Lepidodendron*, and, judging from Heer's figures and description, I do not think that his plant should be placed in that genus. As, however, I have not seen any of Heer's specimens, I cannot be certain that his species is identical with my *Bothrodendron Wiikianum*, though I am strongly inclined to believe it is. I therefore, while adopting his specific name, place the British specimens in their proper genus; and should it eventually be proved that these two species are identical, it will be an easy transition to substitute *B. Wiikianum*, Heer, sp., for *B. Wiikianum*, Kidston.

Localities.—Railway-cutting between Boags Mill and Kates Mill, Water of Leith, Midlothian; collected by Mr James Bennie. Wardie, near Granton, Midlothian; collected by Dr J. M. Macfarlane, F.R.S.E. Little Whickhope Burn, near first branch above Cross Sike, Northumberland; communicated by Mr H. Miller, F.R.S.E.

Horizon.—Calcareous Sandstone Series.

In my "Catalogue of Palæozoic Plants in the Collection of the British Museum,"² I stated the belief that the leaf-scar of *Cyclostigma*, Haughton,³ did not differ in any character from those of *Rhytidodendron*, which is now known to be synonymous with *Bothrodendron*. Last year I had the opportunity of examining the fine collection of Kiltorkan fossils in the Science and Art Museum, Dublin, and in the collection of the Geological Survey of Ireland, Dublin, and

¹ In Kongl. Svenska Vetenskaps-Akademiens Handlingar, Band ix., no. 5 (Stockholm, 1871).

² P. 236.

³ Ann. and Mag. Nat. Hist., ser. 3, vol. v., p. 443 (1860).

this has confirmed my opinion that *Cyclostigma* should be merged in *Bothrodendron*.

The fructification of the Coal-measure *Bothrodendron* is but imperfectly known, and, so far as I am aware, the only cone identified with the Coal-measure members of the genus is that with short bracts figured in this communication. The cones, however, of the *Cyclostigma kiltorkense* are provided with long, linear, lanceolate bracts with a subtriangular base, on which the spores are borne. These have been figured by Schimper as *Lepidostrobus Bailyanus*.¹ Their whole structure reminds one much of Sigillarian cones.

At present so little is known about the fructification of the various species of *Bothrodendron*, that on this important point a comparison cannot be made between the members of the genus; but so long as the generic characters of these Lycopods are founded on the structure of the leaf-scar, *Cyclostigma* must be enrolled in the older genus *Bothrodendron*.

I am aware that the description of the leaf-scar of *Cyclostigma* that I now give, differs in some important points from that given by Dr Haughton² and by Heer,³ as also from the figures and descriptions given by this last-mentioned author in his "Fossile Flora der Bären Insel;" but in many of the specimens a certain amount of shrinkage appears to have taken place, which may have reduced the leaf-scars to the condition in which many of them occur. Be this as it may, the fact remains that when well-preserved examples are examined, it is found that the leaf-scars of *Cyclostigma* contain three cicatricules similar to those of *Bothrodendron*.

EXPLANATION OF PLATE.

Fig. 1. Sigillaria discophora, König, sp., nat. size. 1 a. Leaf-scar enlarged and showing the three cicatricules. Loc. Shale over Whistler Seam, Bonnington Pit, Kilmarnock; communicated by the Rev. David Landborough. Hor. Lower Coal-measures.

Figs. 2-4. Bothrodendron Wiikianum, Kidston, n. sp. 2 Loc. Little

¹ *Traité d. paléont. végét.*, vol. ii., p. 71, pl. lxi., fig. 9.

² *L. c.*, p. 13.

³ *Quart. Journ. Geol. Soc.*, vol. xxviii., p. 169, pl. iv.

Whickhope Burn, near first branch above Cross Sike, Northumberland; nat. size. 2 *a.* Leaf-scar, enlarged. *Hor.* Calciferous Sandstone Series; communicated by Mr H. Miller, F.R.S.E. 3. *Loc.* Railway-cutting between Kates Mill and Boags Mill, Water of Leith, Midlothian. *Hor.* Calciferous Sandstone Series; collected by Mr J. Bennie; nat. size. Specimen in the Collection of the Geol. Survey of Scotland. 3 *a.* Leaf-scar, enlarged. 4. *Loc.* Shore, Wardie, Midlothian. *Hor.* Calciferous Sandstone Series; nat. size; collected by Dr J. M. Macfarlane. 4 *a.* Leaf-scar, enlarged.

Figs. 5, 6. Bothrodendron minutifolium, Boulay, sp. 5. *Loc.* Shale over Whistler Seam, Bonnington Pit, Kilmarnock. *Hor.* Lower Coal-measures; nat. size; communicated by the Rev. D. Landsborough. 5 *a.* Leaf-scar, enlarged. 5 *b.* Subepidermal cicatricules, enlarged. 6. *Loc.* Shale over "Barnsley Thick Coal," Monkton Main Colliery, near Barnsley, Yorkshire; Middle Coal-measures; collected by Mr W. Hemingway; nat. size.

XII. *On some of the Modes of Formation of Coal Scams* (Abstract). By J. G. GOODCHILD, Esq., H.M. Geol. Survey, F.G.S., Acting Instructor in Geology and Mineralogy to the Royal Geographical Society.

(Read 17th April 1889.)¹

After briefly noticing the chemical and physical characters of coal, and its relations to the strata enclosing it, the author discussed the nature of the conditions essential for its formation. These require simply that a requisite quantity of pure vegetable matter should be left under conditions that ensure its fossilisation before its constituents shall have passed entirely into the inorganic condition. These conditions may be fulfilled in any one of many different ways. Inland, for example, coal might be formed through the burial of peat beneath deposits carried into inland lakes. In marine areas it may originate through the sedimentation of inland peat-beds that have been resorted; or it may arise through the submergence and subsequent burial of maritime beds of peat entombed *in situ*. The burial of masses of drift timber has been a common factor in the production of some irregular seams of coal. The decay of marine vegetation, algæ, and the like, and of the spores emanating from these, can hardly be left out of account. The growth, decay, and subsequent

¹ Subsequently printed in the "Colliery Guardian," and also in the "Geological Magazine" for July 1889.

entombment on the spot of lagoon vegetation flourishing in the shallower swamps of deltas that are subsiding intermittently and with minor oscillations of level, has very generally been recognised as the most probable mode of formation of coal seams. Lastly, coal may be formed through the sub-thalassic accumulation of deciduous vegetable matter floated seawards from riparian forests. The author regarded each and all of these various modes as having shared in the formation of the various coal seams known to geologists, and especially dwelt upon this as one of the many proofs that identical results, in the operations of natural causes, may be brought about in a considerable variety of ways.

Leaving any further notice of those modes of formation of coal seams that have been already fully recognised, the author proceeded to discuss in some detail the mode referred to last of all. It was pointed out that where large rivers, draining tropical areas, are transporting, as they usually do, a mixed burden composed of both organic and inorganic substances, these latter, having a higher specific gravity than the greater part of the vegetable matter, are the first to be sedimented. This usually happens within a variable, but generally a short, distance from the land. Animal organisms, as a rule, are also deposited at no great distance from the land; as are also such vegetable organisms as have undergone lengthy maceration, and have become water-logged at this point. Such floating trees, for example, as have travelled long distances, often sink amongst the coarser mineral sediment, root downward, and become entombed in that position as "snags." The smaller boughs, stems, fronds, and leaves may float to greater distances; but may subside through the water at a rate sufficiently high to admit of their reaching the sea-bottom where the sedimentation of the finer mineral matter is in progress. But the lighter deciduous parts of the vegetation, and especially the spores and such organisms whose chemical composition and whose form both enable them to float long, remain in suspension long enough to admit of their transportal to great distances, and they are thus gradually carried by the marine currents to zones far outside those attained by any other material

undergoing seaward transport from the land. The zone where deposition of this kind is in progress must necessarily remain constant the whole time that the relative position of sea and land, and the physical conditions generally, remain unchanged; so that there is practically no limit to the quantity of material that might be sorted out and deposited by itself in this manner.

But both the specific gravity and the power of resisting maceration of different vegetable organisms vary within wide limits. As a result, there is not only a constant separation of the vegetable from the mineral matter going on, but there is, further, an equally constant sorting out of the different vegetable organisms themselves. Those that become waterlogged earliest reach the sea-bottom nearest to the land; whilst those that, from various causes, resist decomposition longer, remain longer in suspension, and are therefore drifted to greater distances by the submarine currents before they finally come to rest on the sea-bottom.

With oscillations of level, or any other causes bringing about changes of physical conditions, the absolute position of these various zones of deposition must necessarily change, and so variation in the constituents of the coal, or the substitution for it of mineral sediments on the one hand, or of oceanic deposits on the other, may be brought about.

This mode of accounting for coal seams does not by any means preclude any one of the others; on the contrary, as deltas advance seaward over areas where deeper water conditions had previously obtained, it would be almost a necessary consequence that lagoon vegetation of some kind or other should prevail over the spot where, at an earlier period, thalassic coal seams had been formed. And it is equally clear that coals originating in any other manner might be inter-stratified with the beds whose history is more especially noticed here.

It appears to the writer that this last-mentioned explanation will enable us to account for the remarkably fine lamination seen in so many coal seams; it will also explain their freedom from admixture with impurities of inorganic origin. We need not longer marvel at the fact that the

several layers composing coal seams should each have peculiar structural characters of their own, which are constant over large areas. Nor need we wonder at that curious fact, much insisted upon by Mr E. Wethered years ago, that we hardly ever, perhaps never, find tree trunks extending upwards through coal seams in the position of growth; which must necessarily have been the normal state of things in the case of coals that have grown *in situ*. It will also enable us to dispense with the complicated oscillations of level, and that very delicate adjustment of the rate of growth of vegetation to the rate of subsidence, etc., which make so many demands on the faith of young geologists accustomed to think for themselves.

Some observations were made upon the close connection that exists between seams of coal and beds of ironstone and of impure limestone. It was pointed out that where decomposing vegetable matter comes into contact with a solution of sulphate of lime, this is decomposed, and carbonate of lime is liberated, if the vegetable matter is in excess. In this way the conditions suitable for the initiation of limestone may be brought about. Where the sulphate of lime is in excess the vegetable matter itself is acted upon; and the author was disposed to regard the amorphous parts of coal as due to this partial dissolution, and subsequent redeposition, of the organic matter. Reference was made to the bearing of this fact upon the absence of vegetable organisms from Red Rocks of all ages.

The paper concluded with some observations upon the employment of the term Coal-measures. The author advocated an extension of the term so as to include all productive coal-bearing horizons in the Carboniferous rocks, qualifying the term by reference to the age of the rocks containing the coal.

XIII. *Zoological Notes.* By FRANK E. BEDDARD, Esq., M.A.,
F.R.S.E., F.Z.S., Prosector to the Zoological Society
of London, Lecturer on Biology at Guy's Hospital.
[Plate V.]

(Read 17th April 1889.)

I.

ON SOME BRITISH SPECIES OF *Pachydrilus* (Pl. V.).

During the month of August 1888, I visited the Marine Biological Laboratory at Plymouth, and occupied myself with the study of the Oligochæta. I have already contributed to the *Journal of the Marine Biological Association* a short notice of such Oligochæta as I was able to find, and have published in the last number of the *Proceedings of the Zoological Society of London* an account of the anatomy of *Clitellio arenarius* and *Hemitubifex benedii*, which are the two most prevalent species of Tubificidæ on the shores of the Sound. Besides these two species, I met with the genus *Pachydrilus*, which is very abundant among coarse gravel at Rum Bay. My study of the material which was obtained from that locality, leads me to believe that there are at any rate two species, upon which I propose to offer some notes to the Society in the present communication.

The genus *Pachydrilus* was distinguished by Claparède (1*), by whom it was found on the shores of Holy Island in the Firth of Clyde and the neighbourhood. He described five species, viz., *P. verrucosus*, *P. crassus*, *P. semifuscus*, *P. lacteus*, and *P. ebudensis*. Of these species, *P. lacteus* is probably to be withdrawn from the genus altogether, as it differs from the rest (and agrees with *Enchytræus*) in having colourless blood. The red or yellow coloured blood of *Pachydrilus* is one of the principal distinguishing features of the genus which mark it out from other Enchytræidæ. Vejdovsky has expressed the opinion that *P. verrucosus* may be identical with Ratzel's *Enchytræus pagenstecheri*. The remaining species have never to my knowledge been reinvestigated.

* The numbers refer to the list of Memoirs cited on p. 105.

Testes and Sperm sacs.

The statements of previous writers about the male gonads and the sperm sacs are a little contradictory.

Claparède remarked (1) that in *Pachydrilus verrucosus* "the testis is not single, as in the preceding species (*P. semifuscus*, *P. crassus*). There are generally at least eight pear-shaped testicles. They fill the ninth and tenth segments, their pedicles converging towards the same point on the wall of the ninth segment, where they are inserted in common. They form then a kind of bouquet."

Vejdovsky (3, p. 39) writes that in *P. pagenstecheri* "there are a number (6-8) of pear-shaped bodies attached to the anterior side of the septum separating segments 10 and 11, which when fully developed completely fill the 10th and 11th segments. They are attached to the septum, and not to the body-wall, as Claparède states. The youngest stages of the testes in *Pachydrilus* form small clear sacs out of the inner epithelium of which the seminal cells arise. The outer wall of these organs consists of polygonal cells, with an obvious nucleus and nucleolus (pl. xiv., fig. 9, *ep.*); under this is a feeble musculature and the inner epithelium producing the spermatozoa. . . . Ripe spermatozoa are set free into the body cavity by dehiscence of the testicular walls." Vejdovsky, in a later work (4, p. 135), considers that the organs which were regarded by himself (in 3) and by Claparède as testes are really sperm sacs; according to this view, the testes of *Pachydrilus* have yet to be found.

Dr W. Michaelsen of Hamburg, who has lately taken up the study of the Enchytræidæ, and has published a number of valuable papers upon their anatomy, has found himself unable to agree with the later views of Vejdovsky just referred to.

Michaelsen considers (2, p. 62) that the organs in question are after all testes, at any rate in the genus *Pachydrilus*. Sperm sacs are, according to Michaelsen, only found among the Enchytræidæ in *Mesenchytræus*.

I have found the testes to be largest in individuals *not* sexually mature, where they form a bunch of divergent

finger-like processes attached to both sides of the septum. These bunches are paired, and lie close on either side of the nerve cord. I gather from Claparède's description that in the species studied by him the paired arrangement of the testes was not apparent; it was so, however, in the examples studied by myself. I am, so far, in accord with Michaelsen, who, taking *P. germanicus* as a type of those *Pachydrili* which live on the shores, and in all of which the testes are lobate, states that the testes are paired and lie in the 11th segment. But I understand Michaelsen to imply that in *P. maximus*, *P. nervosus*, and *P. germanicus* there is only a single pair of testes; my species therefore agrees rather with Claparède's *P. verrucosus*, and it seems to me to be possible that Claparède was in error in stating that the testes form a single mass attached only at one point to the septum. The observations of Claparède and Vejdovsky just referred to seem to imply that there are *two* pairs of testes, but in his latest work upon the subject Vejdovsky (4, p. 132) places the testes of *Pachydrilus* in segment 11 in a table indicating the position of the reproductive organs of the principal genera of Oligochæta. I have studied, by means of longitudinal sections, four individuals of a species which I believe to be identical with *P. verrucosus*, and in all of these there were distinctly two pairs of testes attached to the anterior and posterior surface of the septum dividing segments 10 and 11. Of *P. nervosus* I have studied two specimens; in one (which was immature), there were two pairs of testes occupying an identical position with those of *P. verrucosus*, in the other specimen I could only find one pair attached to the anterior septum of segment 11. It appears, therefore, that there may be some individual variation in the number of testes. In *P. verrucosus* the testes were larger in the immature individuals, where they form bunches of long processes as figured by Claparède and Vejdovsky; in the single fully mature specimen the testes were short, thick, lobed organs; this difference is probably due to the fact that in the latter the greater part of the testicular cells had been converted into spermatozoa, and the organs themselves were in consequence decreased in size.

The figure which Michaelsen (taf. i., fig. 2 f) gives of one of the testicular lobes is rather more like what I have found than the figures of Claparède or Vejdosky.

I could not find any cubical epithelium covering the outside of the testes, but each lobe was ensheathed in a very distinct peritoneum (fig. 7), below which are delicate fibres, as Vejdosky has described. It is no doubt the peculiar nature of this sheath which led Vejdosky to regard the organ as being a sperm sac and not a testis; the presence also of gregarines, which are figured by Vejdosky within the organ, lends some support to this view, since these parasites are so constantly found in the sperm sacs. The sheath of the testicular lobes is closely applied at the base of attachment (fig. 8), but towards the free extremities of the processes it is separated (fig. 7), perhaps by the action of the re-agents, and appears to be quite independent, thus giving rise to a strong likeness to a sperm sac enclosing the developing spermatozoa. In spite, however, of this resemblance to a sperm sac, I agree with Michaelsen that these organs are testes.

It seems to me to be possible that the large size of the testes and the stout peritoneal investment render unnecessary the development of special sperm sacs.

DESCRIPTION OF SPECIES.

The two species differ in their size, one being considerably larger than the other.

The larger species appears to be identical with Claparède's *Pachydrilus verrucosus*. It agrees with that species (1.) in the multifid testes attached to both sides of the septum separating segments 10, 11; ¹ (2.) in the large vas deferens funnel, which is relatively longer than that of *P. crassus*, but shorter and thicker than that of *P. ebudensis*; (3.) in the characters of the perivisceral corpuscles. Claparède does not remark the presence of glands surrounding the orifice of the spermatheca, which exist in my specimens. The only reason which

¹ Claparède does not say distinctly that the testes are found on both sides of the septum (*i.e.*, that there are *two* pairs); it is to be inferred, however, that this is the case, from his statement that they occupy two segments.

prevents me from identifying the species with *P. pagenstecheri* is the fact that, according to Vejdovsky (3, p. 53), there are only a single pair of testes; these, however, are on another page (p. 39) of the same Memoir said to fill segments 10 and 11; there is probably therefore an identical arrangement with that which has been described by myself.

The different habitat of the two species is perhaps against the identification.

The second and smaller species differs from the first (1.) in the form of the vas deferens funnel, which is more like that of *P. crassus*, and apparently also of *P. germanicus* and *P. verrucosus*; (2.) in the complete absence of the peculiar perivisceral corpuscles, which are so characteristic of these worms. In *P. verrucosus* I could not find any difference either in the structure or in the number of these corpuscles in mature and in immature individuals. In the present species I failed to find them either in mature or immature individuals; it may be regarded therefore as tolerably certain that they do not exist. The only other species of *Pachydrilus* in which the absence of these corpuscles has been affirmed is *P. nervosus* (see Michaelsen, p. 58). I am disposed therefore for the present to regard this species as identical with *Pachydrilus nervosus*; it cannot well be identical with any of the species described by Claparède (1).

Michaelsen (2) was not able to state whether the blood of this species is red as in other *Pachydrili*; in my specimens the red or rather yellowish colour is quite apparent.

LIST OF LITERATURE REFERRED TO.

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2. MICHAELSEN, W., Die Oligochaeten von Süd-Georgien, Jahrb. Hamburg Wissensch. Anstalten V. (1888).
3. VEJDovsky, F., Monographie der Enchytræiden. Prag, 1879.
4. VEJDovsky, F., System und Morphologie der Oligochaeten. Prag, 1884.

EXPLANATION OF PLATE.

Fig. 1. Diagrammatic longitudinal section through genital segments of *P. verrucosus*. *a, b*, testes; *f*, funnel of vas deferens; *c*, ovary; *d*, atrial aperture.

Fig. 2. Perivisceral corpuscles of *P. verrucosus*.

Fig. 3. Emergence of dorsal vessel in segment 14 of *P. verrucosus*. *e*, intestinal epithelium; *p*, peritoneum; *d*, dorsal vessel.

Fig. 4. Clitellar epithelium of *P. nervosus*. *e*, glandular cells; *t*, circular; *l*, longitudinal muscles.

Fig. 5. Oviduct of *P. verrucosus*. *f*, funnel; *s*, septum.

Fig. 6. Accurately median section through vas deferens funnel of *P. verrucosus*.

Fig. 7. Transverse section through extremities of testicular lobes.

Fig. 8. Showing one lobe of testis and attachment to septum.

Fig. 9. Spermatheca of *P. nervosus*. *gl*, glands surrounding the orifice.

XIV. *Notes on Pallas's Sand-grouse (Syrhaptes paradoxus) in Scotland during the recent great westward movement of the Species.* By WILLIAM EVANS, Esq., F.R.S.E., etc.

(Read 20th February 1889.)

As the Fellows of the Society will doubtless remember, British ornithologists were thrown into a perfect fever of excitement in May last by the sudden appearance on our shores of innumerable flocks of Pallas's Sand-grouse, a bird which, with a few trifling exceptions, had not visited Europe since the famous irruption of 1863. The species, I need scarcely remind you, is an inhabitant of the vast steppes and plains of Central Asia, being specially characteristic of the deserts of Mongolia, in the southern parts of which it spends the winter. According to some authorities, numbers also winter on the Kirghiz steppes, immediately to the north-east of the Caspian Sea, and thus at no great distance from the confines of Eastern Europe. In the spring immense flocks migrate to more northern localities to breed, and it is at this season also that their periodical irruptions into Europe have taken place. I make no attempt to explain the cause of these sudden westward movements, and would only remark in passing, that the theory of over-population suggested by

their eminent historian, Professor Newton, is not entirely free from objection. My friend Mr Eagle Clarke thinks it not improbable that these erratic wanderings take place only during years of exceptional snow over some part of the breeding area, large numbers of birds being in consequence unable to remain in their usual haunts on their arrival in the spring, and being thus forced to set out in search of new quarters. Be that as it may, the fact remains that the years 1863 and 1888—exactly a quarter of a century apart—witnessed two of these phenomenal movements on a scale unprecedented in the annals of ornithology. As regards numbers, the exodus of 1888 seems to have been by far the more remarkable.

Some valuable records of Sand-grouse in Scotland during the 1863 visitation were communicated to the Society the following year by the late Dr J. A. Smith (*Proceedings*, vol. iii., p. 178).

The records which I am about to place before you in connection with the 1888 visitation do not claim to be even approximately complete as a list of Scottish occurrences, being—except in so far as relates to the Lothians—compiled almost entirely from such of the numerous communications to the newspapers and other publications as I have from time to time in ordinary course observed. They are, however, sufficiently numerous to indicate the large proportions and wide-spread character of the visitation, and show with tolerable certainty the dates of arrival on our coasts.

I may here state that the birds were noticed in Poland on 15th April, then from day to day, in a gradually extending line, at localities further and further to the West, till they appeared at Heligoland on the 8th of May. Herr Gätke's notes from that island, published in the *Zoologist* for July, are well worth transcribing. They run as follows:—

“On 8th of May, 12 birds; 13th, a score; 14th, some; 15th, some; 16th, flights from 5 to 20, 25 shot; 17th, L——, early this morning, on Sandy Island, shot 18; 18th, flights from 20 to 200 head; 19th, a few; 20th, small flocks from 5 to 20; 21st fog, none seen; 22d, hundreds, many females; 23d, flocks from 10 to 40; 24th, many great flights, 50 to

100; 25th" [the date of the letter], "many flights from 5 to 20, very cold northerly wind, blowing rather fresh." Later reports state that some were still to be seen up to July 17th, and that "most flocks flew to the West." On 12th May a flock of about 30, 5 of which were killed, appeared at Listorland, in the south of Norway, not far from the Naze, as recorded by Professor Collett in the *Ibis* for 1888, p. 375. So comparatively rapid was their progress across Europe, that before the news of their appearance on the Continent had reached the British public through the columns of *Nature* for May 17th, the birds themselves had actually arrived on our shores.

I now submit the series of Scottish records which I have drawn up from the materials in my possession. The arrangement is, for obvious reasons, according to locality, and proceeds up the East coast and down the West.

1. Foulden West Mains, Berwickshire.—A female captured on 25th May out of a flock of twelve, and sent to the Zoological Gardens, London, by Mr H. H. Craw,¹ the tenant of the farm—Dr Stuart, Chirnside, *Scotsman*, 4th June; also *East Aberdeenshire Observer*, 8th June, where date of capture is given;² and *Field*, 9th June, where, under additions to the Zoological Society's Menagerie, the sex is stated.³ Dr Stuart informs me that the bird was observed sitting in a field, after the others took flight, by a boy, who succeeded in getting his cap over it, and so secured it. Some days prior to 25th May they were seen by the keeper at Edington hill; about the same time Dr Stuart's gardener saw four pass over Chirnside; and on 3d June the doctor himself, when driving home from Ayton, observed a fine male sitting in a field within 20 yards of the road. (I may here mention that a male, now in the museum at Berwick-on-Tweed, was shot two or three miles south of that town on 5th June and sent to Mr Hope, Edinburgh, for preservation.)

¹ Mr Craw's name was erroneously printed "Cran" in the *Scotsman*, and "Crane" in the *Field* and *Proc. Zool. Soc.*

² The date given in *P. Z. S.*, 1888, p. 291, is the 28th, but this cannot be correct, as Dr Stuart saw the bird in Mr Craw's hands on the 26th.

³ I have since compared the *Field* reports with the list of additions given in the appendix to *P. Z. S.*, 1888.

2. Oldhamstocks Mains (near Cockburnspath), East Lothian¹.—Two males and three females shot on 17th May out of a flock of twenty-three by Mr C. Clarke, the tenant of the farm, and sent for preservation to Mr G. Pow, Dunbar, who advised me of the occurrence the following day, and in whose hands I afterwards saw them. They were feeding in a field of late sown barley newly sèeded with grass and clover. Dr Stuart, in his letter to the *Scotsman* of 4th June, stated that four birds were killed near Oldhamstocks on the same day (25th May) as the Foulden bird was obtained. Mr Clarke, however, is not aware of any, except those he got on 17th May, having been killed near Oldhamstocks, and Dr Stuart admits he must have been misinformed in regard to the facts, as the birds he referred to were those shot by Mr Clarke. Mr Clarke also informs me that for a week or two after he shot the five, he on several occasions saw small parties flying over his farm; that his brother saw seventeen cross Redheugh Hill in a southerly direction on 23d May; and that a day or so afterwards, a flock of sixteen or seventeen, presumably the same birds, were seen at East Reston.

3. Stow, Midlothian.—A male picked up under the telegraph wires on 18th May, and taken to Mr Small, Edinburgh, for preservation. It had been dead only a very short time when found.

4. Wester Broomhouse, near Dunbar.—Four shot by Mr John M. Nelson on 16th May, between 4 and 5 P.M., out of a flock of about a dozen, while feeding in a barley field sown with grass and clover seeds. Three of these, a male and two females, were sent to Mr Hope for preservation, and I had an opportunity of examining them early in the forenoon of the 17th. The fourth bird fell in an adjoining field, and was not found for some days. It was not preserved.

5. Belhaven Sands and adjoining Links of Westbarns, near Dunbar.—Two males and one female shot on 16th May, between 5 and 6 P.M., by Mr T. P. Elliot, 25 High Street, Dunbar, out of a flock of about a score, as they rose from the foot of the sandbank close to the rifle-range and flew over to the Links. Early on the morning of the 17th May Mr

¹ Not "Berwickshire," as stated in the *Field* and elsewhere.

Elliot shot another female out of a flock of seven or eight; and between 4 and 6 P.M. of the same day I had the pleasure of seeing first a flock of fourteen and then a party of four. At same time I found a beautiful male lying dead on the Links, where another male was picked up the following day, and taken for preservation to Mr W. Johnson, Belhaven, in whose hands I afterwards saw it. Both had died of gunshot wounds. The above, with the exception of the last mentioned, are in my collection. For two or three weeks parties, mostly small, were from time to time seen on these Links and neighbouring fields from Dunbar to East Linton. Near the latter place a considerable flock was seen at Phantasie, and likewise on Traprain Farm.

6. Castle Moffat, near Garvald, East Lothian.—A male shot out of a covey of 5 on the Lammermoors, above this place, on 20th May, by the Nunraw keeper. This specimen, which is now in the possession of Mr W. W. Gray of Nunraw, is, I understand, the one referred to in the *Haddingtonshire Advertiser* of 15th June. A party of four were seen near Whittinghame on 26th May—Miss Balfour, *in litt.*, 30th September.

7. Howden Farm, five miles south of Haddington.—Two—probably a pair—shot on 7th June by Mr J. Catleugh, keeper, Bankrugg. One fell into a plantation, and was not found.—Mr G. Pow, *in litt.*, 25th June; also *Haddingtonshire Courier*, 8th June. The bird obtained was stuffed in Haddington. Mr Catleugh tells me it is a female, and is in the possession of his daughter, Mrs Comb, Newton Farm, near Dalkeith.¹

8. Scoughall, on coast, midway between Dunbar and North Berwick.—Two males and one female shot by Mr Thomas Dale, the tenant of the farm, out of a flock of from fifteen to twenty, on 25th May, and sent to Mr Hope for preservation. Mr Dale tells me that two of these specimens are still in his possession, and that the third is in the collection of Mr A. Laidlay, Seacliffe, where another, shot by Mr Dale in the same locality in 1863, may still be seen.

9. North Berwick West Links, and adjoining common.—

¹ I have since seen it.

Flock of about a dozen observed on 24th May flying in a westerly direction over the golf links, as I was informed at the time by Mr J. J. Cowan, who saw them. On or about the same day a flight of thirty or thereby were seen on the shore, and on the 31st May a covey of seven again passed westwards over the golf links—Mr W. Home Cook, *Scotsman*, 2d June. On Archerfield common they were frequently seen about this time, at first in considerable flocks, and then in smaller parties. A male shot there on 10th June, and received by Mr Small on 13th, is now in the collection of Dr Crombie, North Berwick.

10. Aberlady neighbourhood.—About the middle of June a flock was seen near Gullane Point. Towards the end of the month and early in July, a large flock, described to me as composed of about fifty birds, was twice seen passing over Gosford, and once at Fernyness. I had these facts at the time from eye-witnesses.

11. Killduff Mains, near Drem.—One shot on 7th June, as I have been informed by Mr Ronaldson, the tenant of the farm. The bird, which is a male, is in the possession of Mr A. Watt, keeper, Gilmerton House, who tells me it was shot by his son, out of a party of four. Sand-grouse were seen in the same neighbourhood on several subsequent occasions.

12. West Fenton, near Drem.—A male shot on 11th January 1889, and sent by Mr Handyside, the tenant of the farm, to Mr Hope for preservation. It was alone, and had been observed in the neighbourhood for some weeks.

13. Pencaitland, East Lothian.—A male killed against the telegraph wires, 6th June. It was picked up by a party of boys, who observed it fall: it was in company with two others. Sent to Mr Small for preservation. Now in the collection at Whittinghame House.

14. Dalkeith, Midlothian.—One killed a short distance to the east of the town, out of a party of four or five, early in June, and a second obtained in the same locality three or four weeks later. Both were stuffed by Mr J. Braid, Dalkeith, who, judging from drawings I have shown him, states they were females.

15. Near Balerno, Midlothian.—While rambling over

Redford Moor, about three miles south of Balerno, on 26th May, a sudden rush of wings arrested my attention, and, looking round, I saw passing close to me a flock of fifteen Sand-grouse. They came from the west, and having crossed the moor settled on the adjoining field—then newly sown with oats and grass—where for about half-an-hour I had the gratification of watching their movements at close quarters. On again taking wing they pursued their easterly course.

16. Dalmahoy, Midlothian.—On 16th June Mr P. Morrison, assistant to Mr Small, saw eight on the stony slope of Dalmahoy Hill.

17. Near Linlithgow.—On 9th June, Mr W. H. Henderson, Linlithgow, informed me that a small flock of birds answering the description of Sand-grouse had been seen near Ochiltree, a few miles south-east of Linlithgow, about the beginning of the month.

18. Between Stirling and Alloa.—Two shot in the neighbourhood of Cambus, near Alloa, out of a flock on 25th May, as I was informed at the time by Mr W. M. Gow, Airthrey.¹ Writing to me on 10th July Mr Harvie-Brown stated that the survivors were, he believed, still on the Polmaise grounds.

19. Isle of May.—During the latter part of May the island was visited by considerable numbers, and on the 30th three were shot. One of them being only wounded was placed in a cage, where it lived till the beginning of July. For these particulars I am indebted to Mr Harold Raeburn, who was on the island on 6th and 7th June. The bird which died in confinement was sent to Mr Small for preservation. It was a male.

20. South-east Fifeshire, Elie to Crail.—During the last ten days of May and the early part of June, small flocks are reported to have been repeatedly seen in this district, and a few birds killed. Two were obtained near Anstruther on May 26th, and one that had damaged its wing on the telegraph wires near Crail was taken alive prior to 5th June

¹ Since writing the above, I learn from Messrs Michie & Crockart, Stirling, that four birds in all were shot about the same time and place, and that three of these, a male and two females, were preserved by them—the two females being now in the possession of Mr Sword, Curator, Smith Institute, Stirling.

—Mr J. Ross, *Zoologist*, 1888, p. 263; and "J. D.," *Field*, 9th June. On 28th May Mr Small received a male from Elie for preservation. The Crail bird is, I presume, the same as the female presented to the Zoological Society on 3d November by Mr J. Duncan—*Field*, 10th November. It died on 4th December, and was sent to the Edinburgh Museum, but being unfit to stuff, has been made into a skeleton.

21. Tentsmuir, North-east of Fife.—Large parties are reported to have visited this district by the beginning of June; and, receiving the protection of the proprietors, soon settled down: numbers were still there in November. About August 18th five birds were captured alive in a field of rye on Mr Speedie's property (Kinshaldy). Two of these, both females, were sent to the Zoological Gardens, London—Col. Drummond-Hay, *Scottish Naturalist* for October; *Field*, 1st September.

22. Perthshire.—In the *Scottish Naturalist* for October Col. Drummond-Hay records three obtained in the county, namely, a female killed against the telegraph wires and picked up on the railway near Abercairney, Crieff, about the end of May; one shot shortly after 29th May, near Castle Menzies, Aberfeldy; and a male shot near the head of Loch Rannoch, out of a party of three, and presented by Sir Robert Menzies to the Perthshire Society's Museum. A female received by Mr Small from Perthshire on 28th May, and a male also received by him from the same county, on 31st May, were, I understand, the two last-mentioned birds.

23. Arbroath and Montrose, Forfarshire.—One found dead near Arbroath, 5th June; supposed to have flown against telegraph wire—Mr R. N. Simpson, *Scottish Naturalist*, October, p. 340. Considerable numbers—thirty to forty—frequented the Links of Montrose from June to October, and six to eight were killed. One was caught alive in a rabbit-hole. The Montrose Museum received one specimen, a male, shot in June—Mr R. Barclay, *in litt.*, 5th October.

24. Muchalls, Kincardineshire.—One shot by a farmer out of a flock of fourteen during the last week of May—Mr G. A. Leslie, *Field*, 9th June. Mr Leslie at same time mentions that on 1st June he had seen a live bird on board the Danish

schooner "Thor," then lying in Aberdeen Harbour, which had alighted on the vessel on 29th May when halfway across the North Sea.

25. Cruden, Aberdeenshire.—One killed out of a large flock by a boy, with a stone. Mr J. E. Harting—*Field*, 2d June, and *Zoologist* for same month—states that this incident took place on 17th May; and the Editor of the *Scottish Naturalist* for July, probably following Mr Harting, gives the same day; but a notice in the *East Aberdeenshire Observer* of 8th June says it occurred on 15th May, and adds that the specimen was being stuffed by Mr MacBoyle, Peterhead.

26. Peterhead and St Fergus.—Two flocks seen in close proximity to Peterhead, and two birds killed—*East Aberdeenshire Observer*, 8th June. A paragraph in *Land and Water* of 4th August stated that a large number of Sand-grouse had established themselves on the Bents at St Fergus, near Peterhead, and alleged that they had nested there. This drew from Mr A. Wynne Corrie, the lessee of the shootings; a letter, which appeared in the issue of 29th September, to the effect that he had killed four on one occasion and three on another upon these Bents. The three last mentioned—all females—were shot on 6th September and forwarded to Mr Harvie-Brown. I saw them in Mr Small's shop before they were skinned. I gather that the four birds referred to in *Land and Water* of 1st September as shot out of a pack of between seventy and eighty "in the neighbourhood of Aberdeen," were those first obtained by Mr Corrie. The same notice speaks of another pack of about thirty having been seen the same day.

27. Fyvie and Monquhitter.—Mr G. Sim, Fyvie, writing on 4th June to the *Scottish Naturalist* for July, says—"These strange visitors were seen lately in the parish of Fyvie, and were at first supposed to be some variety of plover. They were dispersed in groups, from single individuals up to large flocks; their identity was proved on the 26th May, when two males and four females were shot out of a flock of about fifty on the Waggle Hill, Monquhitter."

28. Links near Pitgaveny, by Elgin. — From Captain

Dunbar Brander's letters in the *Field* of 9th June, 14th July, and 6th October, it would appear that eleven—one of which was shot for identification—arrived here about 18th May. In the course of a week or so, fifteen or sixteen more arrived in two coveys, making, in all, twenty-five or twenty-six on the ground. Shortly after arrival they broke up into pairs, but after remaining thus for about a week or ten days, they, with the exception of three or four pairs, assembled again in one flock. Two eggs, supposed to be those of Sand-grouse, were found, but Professor Newton, to whom they were sent for examination, expressed the opinion that they were water-hen's. The birds were still on this ground up to 1st October.

Reference may here be made to an article in the *Elgin Courant* of 8th June, in which the writer speaks of "strong coveys," or "packs," having been seen in the lower districts of Morayshire, and mentions that several had been shot. He had dissected two males and two females, which were likely to find their way to the Elgin Museum.

29. Coast near mouth of the Findhorn.—On or about 23d May a number settled among the sand-hills between Burghead and Findhorn, and were still there ten days later—Mr R. H. Mackessack, *Scotsman*, 5th June. Mr Harvie-Brown informs me that on the extensive Culbin Sands, to the west of the Findhorn, they "literally swarmed" during the summer. Several hundreds were seen, and he believes one pair at least hatched out young.

30. Nairn.—A covey of four or five seen on or about 18th May "flying inland over the golf-course, which runs alongside the beach"—Mr W. C. Newbigging, *Field*, 2d June.

31. Fort George.—One picked up inside the fort, 7th June. It had killed itself against the telegraph wire—Lieut. H. G. Lang, *Field*, 16th June.

32. Between Loch Ruthven and Farr, Inverness-shire.—One seen, 13th June, in a field by the road-side—Mr W. D. Mackenzie, *Field*, 23d June. The locality is some 10 to 15 miles south of Inverness.

33. Bunchrew, a few miles west of Inverness.—Three

females received from this locality by Mr Snowie, Inverness, between 12th and 16th June—*Field*, 23d June.

It may here be mentioned that, in the same paper, Mr Snowie, under date 12th June, writes that "the first birds were noticed [in the Inverness district, which would doubtless include the shores of the Moray Firth, etc.] about three weeks ago, and since then reports of others have come in daily. Fifteen have been sent to MacLeay for identification, and I have heard of many more." Mr W. Reid, in a letter to the *Scotsman* of 4th June, states that he had just visited the places of business of three birdstuffers in Inverness, and found that each of them had received, and were receiving, numbers of Sand-grouse. He saw upwards of a dozen. They had been sent from Inverness-shire, Ross, Sutherland, and Caithness.

34. The Black Isle, north of Inverness.—Two females received by Mr Snowie between 12th and 16th June—*Field*, 23d June.

35. Delny, near Invergordon, on the Cromarty Firth.—One shot by a gamekeeper, out of a flock of twelve, early in June—*Northern Chronicle*, 6th June.

36. Thurso.—One, which had dashed itself against a telegraph wire, picked up on or about 17th May—*Orkney Herald*, 23d May.

37. Sandside near Reay, Caithness.—A female killed by coming in contact with the telegraph wires, 21st May; sent to Mr Lewis Dunbar, Thurso—Mr W. Reid, *Scotsman*, 4th June. I learn from Mr Harvie-Brown that Sand-grouse were abundant along the east and north coasts of Caithness in the latter part of May and during June, and, as already mentioned (No. 33), examples from that county were preserved by Mr MacLeay, Inverness.

I may here state that Mr Eagle Clarke informs me, a bird, said to be from the north of Scotland, was exposed for sale in the Leeds Market in December.

38. Dalvine Lodge, Strath Naver, Sutherland.—Flock of twenty to twenty-five "passed over, . . . and pitched on the moor opposite," 11th June—Mr H. Griffith, *Field*, 23d June.

39. Gubernisgach, Reay Forest, Sutherland.—A male shot on 18th May and sent to Mr Hope for preservation.

40. Orkney Islands.—On 17th May, Mr John Gilmour, light-house keeper, Pentland Skerries, shot four—all females—out of a flock of twelve; three of them were sent to Mr Small for preservation, and the remaining one to Mr L. Dunbar, Thurso—*Orkney Herald*, 23d May, and Mr W. Reid, *Scotsman*, 4th June. The following also passed through Mr Small's hands, namely: A male, received from Stronsay, 2d June; a male from Kirkwall, 4th June; a female from Kirkwall, 20th June—had been found dead, and could not be stuffed; a male from Kirkwall, 21st June; another from Kirkwall, 1st November; and on 18th December the skins of a pair said to have been shot in Orkney in September. Large numbers, it seems, visited Orkney; and I was told, no longer ago than 28th ulto., that some were still there.

41. Shetland Islands.—A goodly number appear to have visited these islands also. Mr Harvie-Brown received a female from Unst, which was killed on 16th May; and the following have come under my own notice, namely: male and female received from Unst on 21st May by Mr Hope, who informed me they were killed on the 18th—the male is now in the Edinburgh Museum; male and female, from Unst, received by Mr Hope on 29th May—killed five or six days previously; male and female, from Unst, received by Mr Hope on 11th June—said to have been killed on the 4th—female now in Edinburgh Museum; and, finally, a female from Unst received by Mr Small on 14th June. A paragraph in the *Dundee Advertiser* of 14th June, says—"These birds . . . have been seen and several examples obtained in Shetland during the past three weeks. One was secured in the island of Fetlar on the 7th inst. . . . A group of eight birds was seen in the vicinity of Lerwick a few days ago."

42. Parish of Gairloch, Ross-shire.—About 1st June fifteen were noticed on a remote farm near the sea-shore. During the following week the flock broke up. Three were seen on 9th June; others, about the same date, at a place three miles off, also near the shore—Mr J. H. Dixon, *Field*,

7th July, and *Inverness Courier*, as quoted in *Scotsman* of 4th July.

A communication, signed "M. P.," in the *Field* of 21st July, reporting that three birds had been seen (apparently about the middle of the month) on a Ross-shire shooting, may here be mentioned.

43. Skye.—Writing to me on 15th June, the Rev. H. A. Macpherson mentioned that he had just heard of their appearance in Skye, and he has since kindly supplied me with the following details, namely:—A flight of fourteen visited Duntulm in the north of the island on 28th May, when one was winged. They were seen at Waternish, flying for the Minch. Some interesting facts regarding the above captive, referred to as "he," are given in Mr Macpherson's paper in the *Trans. Cumberland and Westmoreland Association*, 1888, p. 63.

44. Lewis, Outer Hebrides.—Flock of thirteen observed on the Sandhills at the mouth of the river Coll, about six miles from Stornoway, on 7th June. They were put up twice; the second time they disappeared inland in a north-westerly direction—Captain T. H. Plumbe, *Field*, 16th June. In the same newspaper of 22d September, Mr R. F. Cook stated that several birds had visited the island of Lewis, and that some which were shot there had been forwarded for preservation to Mr MacLeay of Inverness in whose possession he had recently seen them.

45. Benbecula and South Uist.—In the *Ibis* for 1888, p. 492, Sir J. W. P. Campbell-Orde publishes a letter from Dr John MacRury (erroneously printed Mackney), dated 25th May, to the effect that on or about 22d May, and two or three succeeding days, he had observed a solitary bird on a moor in Benbecula, and that on 25th May he had observed on the "Machair" there, a covey of ten. The same flock is referred to by an anonymous correspondent, "J. J. F.," in the *Scotsman* of 14th June, who, writing on 8th June, speaks of them having been seen on the Machair since the last week of May.

Mr A. Hogg tells me that when in Oban last summer, he saw, in the hands of Mr Scutts, taxidermist there, a pair

which had been received from Loch Boisdale, South Uist, about 18th June.

46. Mainland of Argyllshire.—Mr Hogg also saw in Mr Scutts' hands a specimen from Glencoe, and another from the neighbourhood of Loch Awe, both obtained about the middle of June. Further south, at Kilberry, near Tarbert, nine were seen flying over on 16th September—Mr J. Campbell, *Field*, 22d September.

47. Island of Tiree.—Writing on 18th June, Mr Harvie-Brown informed me that they had "turned up" here in numbers. Among the additions to the menagerie of the Zoological Society, reported in the *Field* of 23d June, are two Sand-grouse—male and female—from Tiree, presented by Lieut.-Col. Irby and Captain Savile Reid, who are doubtless the two tourists referred to in Mr J. Myles' letter to the *Scotsman* of 11th June, from which it appears that the birds were captured prior to 8th June.¹ The presentation of this pair is alluded to in the *Proceedings of the Zoological Society for 1888*, pages 413 and 675, but I can find no mention of any having been presented by the Duke of Argyll, as stated in the *Zoologist* for July, p. 261, and conclude the Tiree birds were meant.

48. Near Maybole, Ayrshire.—Writing under date 8th December, Mr H. Wallace, Cloncaird Castle, Maybole, says, "My keeper this morning brought me a Pallas's Sand-grouse alive. It was caught by my under-keeper, owing to the fact of its being to a certain extent disabled, presumably by other birds"—*Field*, 15th December.

49. Near Stoneykirk, Wigtownshire.—A small flock was observed near Stoneykirk in the early part of June, as I have been informed by Mr P. Adair.

50. Mouth of the Nith, near Dumfries.—Large numbers appear to have visited this district, more than sixty being present at one time. They were first observed on 7th June, and by 17th August only nine remained. The others had gradually dispersed. Seven were shot, all within a few days of their first appearance—Mr R. Service, *Ibis* 1888, p. 491;

¹ Since the above was written, I learn that the date of capture was 28th May.

and Rev. H. A. Macpherson, *Transactions Cumberland and Westmoreland Association*, 1888.

Through the courtesy of the taxidermists in town, I was enabled to examine in the flesh nearly the whole of the birds sent to Edinburgh for preservation, and had thus an opportunity of making a number of notes on measurements, weights, and the condition of the birds generally, which, together with the foregoing list of occurrences, form the basis of the following remarks:—

I. *Dates of arrival, extent of the immigration, and subsequent movements of the birds.*—If the statement in the *East Aberdeenshire Observer* of 8th June be correct, the earliest date I have a note of is 15th May, when a flock is said to have been seen at Cruden, a few miles south of Peterhead. Anyhow, it is certain that by the 16th the birds had made their appearance at localities so far apart as Dunbar and Shetland. On the 17th they were detected near Cockburnspath, at Thurso, and in the Orkneys; and on the 18th they were seen on the coast near Elgin, and at Nairn. For a few days there is a lull—scarcely a record, and these hardly referable to new arrivals. On the 24th and 25th, flocks were observed at North Berwick and elsewhere, which there is every reason to believe were fresh arrivals, and during the next fortnight we find them distributed in large numbers practically along the entire east coast of Scotland. Although the data at my disposal is, doubtless, far from complete, I think we may fairly conclude that few, if any, of the immigrants reached the Scottish shores before the middle of May; that about that time considerable detachments arrived almost simultaneously at various points from East Lothian to Shetland; and that in the course of the last week in May and the first week in June the greatest movement took place, hosts of birds pouring, in wave-like fashion, on to our whole eastern seaboard. This is very much what a reference to the Heligoland notes, transcribed on pages 107 and 108, would lead us to expect. By this I do not mean to infer that all, or even any very considerable portion, of our birds came by way of that island, for, by the time the wave of immigration had reached the eastern shores of the North Sea, it had spread northwards

and southwards over the greater part of Europe. . A flock of thirty, it will be remembered, had reached the south of Norway by the 12th of May.

Some of the birds seem to have made but the briefest halt on the coast, and then proceeded inland in continuation of their westward flight. Thus one was obtained at Stow in the south-east corner of Midlothian on 18th May, and on the same day another was killed at Gobernuisgach in the centre of Sutherland. Other records from inland localities soon follow. As early as the 22d May a solitary example had reached Benbecula in the Outer Hebrides, where more made their appearance on the 25th. On the 28th a flock was observed in Skye, and in the course of the next few days their presence was noted in many other localities on the west coast. I cannot help thinking that a few at least, both at this time and later on, must have found a watery grave in attempting to cross the Atlantic.

Wherever ground suitable to their habits and of sufficient extent could be found, there concentration soon took place; consequently in the course of the first fortnight of June, we find them settled in large numbers, and with more or less persistency, in such districts as Tentsmuir, near the mouth of the Tay; the Links of St Fergus, on the coast of Aberdeenshire; the Pitgaveny Warrens, near Elgin; the Culbin Sands, on the shores of the Moray Firth; and on the Scottish side of the Solway. In many, however, the restless spirit seems never to have subsided even for a day, and consequently all through the summer wandering parties, generally small, were met with in almost every district. In some of the settlements above mentioned, hopeful signs of true colonisation were soon visible; a breaking-up of the flocks into pairs became more or less general, and several persons confidently expected that, in the course of the next few days, Sand-grouse eggs would be freely laid on Scottish soil. But these hopes were doomed to speedy disappointment by the sudden repacking of most of the birds. Although there may be strong presumption that a few pairs did breed, I have not yet seen any positive proof of the fact. The supposed eggs obtained by Captain Dunbar Brander in Elginshire are, in

Professor Newton's opinion, those of a water-hen ; the pair of birds sent to the Zoological Gardens from Tentsmuir in August, and announced in the *Scottish Naturalist* as young ones, are not regarded as such by Dr Sclater, the Society's Secretary (*in litt.* to Mr Eagle Clarke, 1st February); and the three sent in September to Mr Harvie-Brown from the St Fergus colony, in the hope that they were young birds, were unquestionably adult females, passing through the moult. Mr Harvie-Brown informs me, however, that he has received evidence as to a pair having hatched young in the north of Scotland, so strong that Professor Newton is disposed to accept it. For the facts of this case we must be content to await the publication of the report on the recent Sand-grouse irruption, which the Professor has undertaken to prepare for the *Ibis*.

During late Summer and Autumn the birds were still fairly plentiful, though much less generally distributed, having for the most part congregated into large flocks or packs. By the beginning of winter their numbers appear to have been greatly reduced, but where they had gone to I am not prepared to hazard an opinion. Some have undoubtedly wintered in the country, and are still with us ; and it is to be hoped that the Act recently passed by Parliament for their protection will prove an efficient instrument to that end.

II. *Numbers and Mortality.*—Any estimate of the numbers that entered Scotland must, from the very nature of the case, be to a great extent of an arbitrary character. After having carefully analysed the list of occurrences, and made allowance for double records and other elements of uncertainty, I have come to the conclusion, that the number which reached Scotland cannot have been less than from 1500 to 2000. In the Forth district alone, fully 400 have, from first to last, been seen, but when double records are allowed for, I scarcely think we can claim for it more than from 200 to 250 of the direct arrivals. As far as I can learn, the Moray Firth district received by far the largest portion of the immigrants.

The list of killed and wounded is regrettably large. An analysis of the records I have submitted gives a total of about 150, but the actual number destroyed must have con-

siderably exceeded this figure; we cannot, I think, set it down at less than 200. The great majority, say about 85 per cent., succumbed to the destructive power of powder and shot, while a good many—probably not far short of 10 per cent.—met their death by coming in contact with telegraph wires. In the Forth area, where no less than 35 of these interesting visitors are known to have been killed, I find that in eight instances where average sized flocks were fired into, one bird in about every five fell. In other districts, however, the proportion killed would appear to have been considerably less. Out of 81 cases where the sex is noted, 36 are males and 45 females.

III. *Condition and Food.*—Though not fat, the birds, as a whole, were by no means in bad condition when they arrived. My notes indicate that the average weight of males was then about $8\frac{1}{2}$ oz., that of females about $8\frac{1}{4}$ oz., but individual variations were considerable. For instance four males, weighed on 17th and 18th May, were respectively $9\frac{1}{2}$, $8\frac{1}{2}$, $8\frac{1}{2}$, and 8 oz., and four females, $9\frac{1}{4}$, $8\frac{3}{4}$, $8\frac{1}{4}$, and $7\frac{3}{4}$ oz. Improvement in their condition was soon apparent. Thus, by the middle of June, males weighing $9\frac{1}{2}$, $9\frac{3}{4}$, 10, and 10 oz., had passed through my hands; and three females, weighed in September, were respectively 9, 9, and $9\frac{1}{2}$ oz. Heavier examples are recorded by Mr Sim of Fyvie, who states in the *Scottish Naturalist* for July, that males shot in Aberdeenshire on 26th May weighed $10\frac{1}{2}$ oz., and females 10 oz.; but no wonder they stood the test of the scales so well, for we are told that “the stomach of one contained 370 seeds of barley and thousands of seeds of clover.”

As bearing on the then much discussed question,—the probability of the birds breeding with us,—I dissected several of both sexes, but did not find the reproductive organs in a more advanced state than was to be expected at the season of the year, quite apart from any serious intention the birds may or may not then have had of nesting. The most advanced case was that of a female—one of the earliest victims—the ovary of which contained, in addition to the usual mass of small ova, three measuring roughly .4, .3, and .2 of an inch. The writer of the article in the *Elgin Courant* of

8th June, states that in a female dissected by him he found "three well-developed but as yet shell-less eggs, the largest being what we would suppose nearly the full size; while in the ovary there were from twelve to twenty very minute eggs, some of which were slightly developed."

With regard to plumage, I noted that, in the case of birds obtained at the beginning of the immigration, it was particularly clean and bright. Many of the feathers, however, presented a more or less worn appearance at their margins, clearly indicating that some considerable time had elapsed since they were acquired; but even where this was scarcely visible, as in the case of a most beautiful male with the two central rectrices still so short that they were hidden by the upper tail coverts, the absence of the delicate bloom afterwards so noticeable in newly moulted specimens, and still present on the male shot near Drem on 11th ult., also pointed to the conclusion, that if a spring moult takes place, it can be only a partial one. The brilliancy and general condition of the plumage rapidly deteriorated. A female, for instance, shot early in June, had the first primaries worn down to the length of the second, and soiled specimens now became the rule. By the end of the month signs of moulting had made their appearance, and steadily progressed throughout the autumn, so that by October or November all the birds were clad in completely new plumage. Three females, examined early in September, had the new primaries and tail-feathers well grown, though not quite fully developed. One of them had the legs almost bare, the old feathers having dropped off while the new ones were just bursting their sheaths. The newly acquired plumage was not in any essential point different from that worn by the birds on their arrival. The orange about the head and throat, the chestnut bar on the wing, and the lavender grey on the chest, were a shade darker on the new feathers, and the whole plumage was suffused with a most delicate bloom. The colour of the iris in all I examined was very dark hazel, the bare skin round the eye pale-blue or lavender, and the beak bluish-grey tipped with dark-brown. Only one female showed any signs of the pectoral band so characteristic of the other sex. In

full-plumaged males the average expanse from tip to tip of the wings was a little over 27 inches; total length from point of bill to tip of tail, fully 16; wing from flexure, $10\frac{1}{4}$; projection of first primary beyond the second, $1\frac{5}{8}$; central rectrices about 8 inches (the longest measured was $8\frac{3}{8}$), exceeding the next by about $3\frac{1}{4}$. In the females the average expanse was about $24\frac{1}{2}$ inches; the total length fully 14; wing from flexure, 9; projection of first primary over the second, 1 inch; central rectrices nearly 6, exceeding the next by nearly 2 inches. Tarsus in both about 1 inch, and foot $\frac{3}{4}$.

The crops of the bulk of those I dissected in May and June were filled mainly with clover and grass seeds, mixed with grain—either barley or oats. As a rule the clover predominated, though in a few instances little else but grain was present. Green food was found in the stomachs of some, particularly those from Shetland. In winter they appear to have fed mostly on noxious weeds; the crop and stomach of the bird shot near Drem on 11th ult., for instance, contained nothing but the seeds of *Atriplex* and *Polygonum*, and these in large quantity. Pupæ of a small dipterous insect were twice found among the contents of the crops.

IV. *Habits and Call-Notes*.—Though I had the satisfaction of seeing flocks of these most interesting birds on two different occasions, the opportunities for observing their habits were so meagre, that I have scarcely any remarks to make on this head. The localities they chiefly affected were extensive commons and sandhills—bents or links as they are frequently called—on the coast. From these haunts they made daily excursions to the adjoining arable lands, where an abundant supply of food was readily procured. Those I fell in with on the sandhills sat so low and motionless, that I could not detect them till they suddenly sprang into the air and sped away on rapid pinions. On wing they undoubtedly at the first glance remind one of a flock of Golden Plover, as has been so often remarked. When feeding on the newly sown fields, I observed they, as a rule, moved all in one direction, keeping well in line and rapidly picking up the grain very much after the manner of a flock of pigeons. The short legs give rise to a sort of rolling gait, but they run with consider-

the site of the old Borough Loch—were laid open by a series of deep drains, the sections of which exhibited in the “lower and earlier deposits a fine silt separated into laminæ as thin as pasteboard,” crowded with impressions of the common water flag and reed, then above the silt “a bed of grey marl composed mainly of lacustrine shells with an occasional land shell.” Over this marl occurred in some parts three feet of peat-moss, having still preserved in it the “glossy elytra of beetles in their prismatic tints of azure and green.” The silt is considered to be a rain wash of clay and soil from the ground surrounding the old lake. The marl is referred to as the “dead exuviæ of generation after generation of freshwater Mollusca for many ages, which at length filled up the depths of the lakes till there was no place for the living; then water mosses sprang up in the marly shallows, and gradually contracted its area, until what had been open water became unsightly morass, and the old Borough Loch was transformed into the Meadows.” Mr Miller records two species of *Cyclas*, three species of *Limnea*, but makes no mention of *Ostracoda*, probably because in 1842 their significance as indicative of lacustrine conditions was not recognised.

The lake marls we have examined are ten in number, and were gathered within the last twenty years from the various exposures which occurred during that time; not, it should be mentioned, with the view of being described and their organisms enumerated as in this paper, but partly as employment for leisure hours, and partly at the instance of Mr David Robertson, who was engaged in the study of the recent freshwater *Ostracoda*, and who made some use of the material collected. It was only within the last few months that the idea of making this use of the surplus material occurred to us as preliminary to a more exhaustive study of the freshwater Crustacea of the Edinburgh district which one of us (T. Scott) intends to make. Six of the marls or silts were obtained from within or immediately around Edinburgh; three—those of Corstorphine, Hailes, and Redhall—about four miles west of it; and one—that of Kethymyre—about six miles to the north across the Forth, and is included because it conforms, in the conditions and circumstances of

its deposits, to the most typical lakes within the immediate range of our inquiry. The times represented by these lake silts or marls extend from the end of last century, as in the cases of the North Loch and the Borough Loch, back to the interglacial lakes of Hailes and Redhall. By the end of last century is simply meant that about that time the North Loch and the Borough Loch became extinct as lakes. As to the time when they first became lakes, Hugh Miller's later suggestion in 1854—by which he amended his first suggestion in 1842 by extending their period from the time of the Noachian flood about 4000 years ago to the times of the later upheavals of the land, which in the case of the higher lying lakes might be four times 4000 years ago—must be taken as the nearest approach to the actual date we can at present make. The interglacial lakes of Hailes and Redhall must be considerably earlier in date than any of the others, which must all be reckoned postglacial; but to put it in figures is beyond our present intentions.

THE NORTH LOCH.

The material from this lake was given to us in 1871 by the late Mr J. Wallace Young, who obtained it from his uncle, Mr Bell, for many years chief engineer of the North British Railway. It was taken from the excavations for the new arrival platforms made at that time for the trains coming from the west. We cannot give any details of the thickness or extent of the deposit of which it was a part, but as it is said that the North Loch stretched from the Castle eastward to beyond the North Bridge, it was probably extensive, and most likely represented several diverse conditions determined by the depth and exposure of the water. The material from which the shells and Ostracoda were obtained was not marl as in most instances, but a brown earthy mud, which did not separate into dust or grains, but remained in small solid pellets even after boiling a considerable time. It is therefore evidently from the latest deposit ere the loch was drained dry, and the life remains are probably not more than 100 years old. When the railway was made

in 1843, all the deposits laid down by the waters of the loch would be thoroughly exposed; but we have not seen any notices of the exposures at that time.

BRISTO PORT LAKE.

In a cutting for a sewer at Bristo Place in 1872, a deposit of black mud was exposed, portions of which were secured and washed. A few seeds were found in it, and a good number of oblong bodies somewhat boat-like in shape, yellowish-brown in colour, with two black spots or dots near the middle. These bodies have been determined by Dr Woodward and Professor G. S. Brady to be the epiphia or winter eggs of *Daphnia*, and being such, they prove that a small lake or water pool existed in the grounds just outside of Bristo Port. At that time Edinburgh was a walled city, probably about the time of Flodden, say in the fifteenth century. No Mollusca or Ostracoda were found with them, but they of themselves are sufficient to prove lake-like conditions.

LAKE, NORTH SIDE OF BLACKFORD HILL.

The material from this place was sent as a curiosity to Professor A. Geikie in 1872 by a builder who had made some drains in the hollow on the north side of Blackford Hill. No particulars were given of the circumstances of the deposit, but it is evident, from the character of the material itself, a perfectly pure marl, that it had been deposited from the waters of a small lake formed by, and probably drained by, the Pow Burn, which flows through the hollow. It was probably of long standing, as the marl was quite free from any clay or earth, or vegetable matter, in the shape of peat, or stems or roots of water plants; the only vegetable remains in it being seeds of *Chara*, which are very numerous, and in good preservation.

JORDANVALE LAKE.

The Suburban Railway cut through a series of recent deposits in the hollow between the ridge on which Morning-

side Asylum stands and that in which the Plewlands Cemetery is situated. The Jordan Burn flows through the hollow, and doubtless now drains off the surplus water that once stagnated in it and formed a lake. The section cut through was (1.) vegetable soil, 2 feet; (2.) peat, 3 feet; (3.) marl, irregular in thickness, but generally 2 to 3 feet. In places, however, it went down 15 or 16 feet, but in these places it extended only 2 or 3 feet in breadth, showing that the marl occupied deep holes or "plums" in the bottom of the lake. The marl was free from peaty matter, but was crowded with stems of water plants, very thin and ribbon-like, of a yellowish-green hue. In washing they could be easily floated off, and the animal remains secured without any difficulty. The marl and peat extended along the railway cutting several hundred yards from near the rock section at Myreside to within a short distance of Morningside Station, and its breadth was of course only shown by that of the railway, but it probably extended from side to side of the hollow, which might be 100 yards.

THE BOROUGH LOCH, NOW THE MEADOWS, EDINBURGH.

The material examined was obtained in 1871 during operations then in progress to level the West Meadows and raise them several feet higher. The soil was lifted and drains made, and rubbish from building operations in the town laid down to the thickness of 3 or 4 feet in some places, and in others 6 or 7 feet, and then the soil was spread over the surface, and the grounds restored to grass again. The depth of the marl was, I think, about 3 feet, and was topped by peat as described by Hugh Miller in the article already referred to. The marl washed with difficulty, and there were comparatively few Ostracoda in it, which we suppose due to their cast-off coverings having, through decay, lost the animal matter interwoven in their substance. The mineral constituents were resolved into white mud, which is the principal component of these old lake marls. The lake from which the Meadows' marls were shed was well known as the Borough Loch.

HOLYROOD LAKE.

In the years 1887 and 1888 a new sewer was made through the hollow that lies between Salisbury Crags and the slope of St John's Hill, and several beds of gravel, clay marl, and peat were cut into, which marked the site of an old lake. For distinction sake it may be called the Holyrood Lake, as, from the configuration of the ground, the lake deposits must extend under the palace. These lake deposits have been referred to by three of our local geologists:—*first* by Mr Andrew Taylor in describing the strata cut into in making a gas tank, *Trans. Geol. Soc. of Edinburgh*, vol. v., p. 44; *secondly* by Mr John Henderson, also in same *Transactions*, vol. v., p. 407; and *thirdly* by Messrs J. A. Johnston and J. Lindsay in *Trans. Edinburgh Naturalist Field Club*, vol. ii., p. 135, who give a plan and section from measurements and bores furnished by Mr J. Massie of the Burgh Engineer's Office. One of the bores may be quoted entire, as it gives the strata passed through from the surface to the rock-head—(1.) Forced material, 3 ft. 2 in.; (2.) yellow clay, 2 ft. 4 in.; (3.) peat, 3 ft.; (4.) marl, 9 ft.; (5.) mud (white and brown), 2 ft. 6 in.; (6.) clay (blue and red), 1 ft. 9 in.; (7.) rough gravel, 4 ft. 6 in.; (8.) clay and small stones, 5 ft. 6 in.; (9.) blue clay, 7 ft. 7 in.; (10.) Blaes;—in all, 39 ft. 3 in., 26 feet of which we may consider as deposited by the ancient lake, proving that the lake period was a long one from first to last. Those who wish further details may consult with advantage the three papers to which we have referred, especially that of Johnston and Lindsay, which is the most minute in its descriptions. For ourselves we shall notice roughly the section as it appeared to us while gathering the samples of marl and clay. Lowest was a bed of sand and gravel, the gravel being well rounded and the sand free from clay or earth; then a bed of white clay without shells, or only a few; then a marl crowded with shells, very cohesive and felted with vegetable *débris*; then uppermost a bed of peat, brown and compact, in which twigs and portions of wood were frequent. The shells, as usual in these

old lake marls, separated with difficulty from the white mud; and the Ostracoda were loth to "rise again" from the charnel dust in which they had been buried. The white clay was more amenable to the persuasions of washing and boiling, and the Ostracoda came forth in great numbers from the charnel dust. There was very little vegetable matter in this clay, merely thin ribbon-like stems of water plants, of which only the epidermis remained. There were a few seeds of the larger plants, and those of *Chara* were in thousands.

The Holyrood Lake must have been of very ancient date, probably existing a long time before the building of the Abbey or even the Palace—that time in sooth when the "doe made its den" in the woods which we know once occupied the site of Holyrood.

CORSTORPHINE LAKE.

On the farm of Broomhouse, at the distance of several hundred yards from Corstorphine Station on the line of the short cut railway from the Forth Bridge, it was found necessary to make a culvert for an underground water-course, and a cutting 7 feet in depth was made for that purpose. The soil cut into was not boulder clay or gravel as in other cuttings in the neighbourhood, but lake silt and peat. The silt was crowded with freshwater shells and Ostracoda, and the peat was composed chiefly of the stems of water plants, being essentially a water peat. The cutting was not seen by us, and we cannot give details of the section. From answers to inquiries, however, we learnt from the workmen that the peat was not lying above the silt, but interstratified with it. The 7 feet did not exhaust the silt with shells, which was evidently several feet more, as the culvert had to be founded upon concrete. The ground through which the underground water-course ran is still slightly lower than the surrounding fields, and there can be no doubt that a small lake existed here for a considerable time ere say 10 feet of silt and shells could be formed, nearly every grain of which seems to have been once organic. The plain in which this old lake occurs, extending from Edinburgh to near Gogar, is said in the

Geological Map of the district (Edinburgh, Sheet 2) to be an old alluvial plain, and from traditions we learn that the eastern part of it from Edinburgh to Corstorphine was formerly a marsh difficult to cross, especially at night, and that a beacon light used to be affixed to the gable end of Corstorphine Church to guide benighted wayfarers safely across it. This little lake, of which the silt and the shells are now the only memorials, was doubtless one of many which once studded this plain in parts with water pools, each not many acres in extent, in which the little life which luxuriates in plashy places dwelt for many generations through a lengthened period ere a bed of organic silt 8 or 10 feet in thickness could be elaborated, every grain of which silt was without doubt once alive.

KETHYMYRE LAKE.

In making a private railway from Binnend Oil Works to Kinghorn in 1887, an old lake marl was cut through in a low flat hollow named Kethymyre at the foot of Rodanbraes, about two miles N.E. of Burntisland. The section exhibited was as follows:—(1.) Peat, 1 ft.; (2.) marl, 1 ft.; (3.) greenish clay with shells, 3 ft.; (4.) clay without shells, 1 ft.; (5.) boulder clay. The peat was rusty brown and very loose in texture, and an oak tree trunk about $1\frac{1}{2}$ feet in diameter stretched across it. At one place an irregular bed of sand 3 to 4 feet in thickness, and striped with bands of light and dark red sand, seemed at one place to be upon the marl and at another upon the boulder clay. I note this as giving a rather ancient date for the lake of Kethymyre, but still the name shows that it was extant during the human period. The height of this flat space is about 150 feet above the sea, and its situation not far from the shore of the 100-foot beach period. These peat and marl beds are still (1889) accessible just west of the bridge which carries the road to Kinghorn over the railway.

ANCIENT LAKE AT HAILES QUARRY.

In the summer of 1886 a tarring in the N.E. of Hailes Quarry exposed deposits which could only have been made

by the waters of an ancient lake, as the sections which I will detail will prove. Upon the rock head lay 3 or 4 feet of boulder clay; above this were several feet of sandy clay in which were two layers of peat, one about two inches, the other about a foot in thickness. What lay upon the sandy clay was uncertain, as the ground had been much disturbed by alterations caused by the operations of the quarrymen, and sometimes quarry *débris* rested on it, and sometimes what seemed to be natural soil, and at one place a patch of boulder clay which, seemingly in its natural position, would indicate an interglacial position for the old lake silts and peat. But that this sandy clay with its layers of peat belonged to some of the later stages of the glacial period is certain, as in the middle of it were two trap boulders standing side by side, each about 6 feet in height, and 2 or 3 feet in diameter, and only 4 or 5 inches apart. They seemed as if they had been originally only one, and had been split in two *in situ*. Round these boulders the sandy clay had been deposited, and the gap between was filled with vegetable matter which had grown in the lake, and been drifted into the gap or slit. Now it was in the laminated clay at the bottom of these old lake deposits that the shells and Ostracoda were found, and within 2 feet or so of the base of these boulders under which the laminated clay extended.

From the washings of the peat many seeds were obtained, 25 species of which have been determined by Mr C. Reid; and also many insect remains, chiefly beetles, nine species of which have been determined by Mr C. O. Waterhouse of the British Museum. There was no marl in this old glacial lake of Hailes, and the shells and Ostracoda occurred in silt.

There are other evidences which may be stated here that seem to prove that the peats and silt found in the north-east corner of Hailes Quarry were deposited in an interglacial lake, or perhaps more correctly in the lake-like expansions of a water-course or river. In 1886 a tiring in the south-west corner of Hailes Quarry, directly beneath the farmhouse of Kingsknowe, showed in section, first, upon the rock head

1 foot or so of boulder clay, then 18 inches of fine laminated silt, then about 10 feet of sand and gravel with large waterworn boulders of trap rock. Upon this gravel lay 20 to 30 feet of boulder clay, with the farmhouse of Kingsknowe crowning it. At the west end of this section the sand and gravel abutted abruptly against the boulder clay, which then extended from the rock head up to the farm buildings as a steep cliff more than 30 feet in height. The eastern side of this bed of sand and gravel was not seen, as it was covered by a mass of run *débris* which had slipped down from above. Beyond this slipped stuff, the sand and gravel was again seen resting on the rock with a much larger proportion of waterworn blocks. It was clear from this fact that the gravel was the *débris* of a river which once occupied the hollow it now fills, and that the quarry had cut it obliquely, exposing its western end, while the eastern was hid by the *débris*. In 1886 this gravel was free from vegetable remains, but in 1884 occurred several small lumps of peat that had evidently been torn from a peat bed, and carried away and deposited in the gravel forming by the torrential action of the river. These stray pieces of peat, when washed, were found to be merely masses of granular vegetable *débris*, quite identical with peaty matter washed from sand got in 1887 *in situ* in the south-east corner of Hailes Quarry, which consisted only of vegetable *débris* and spores of *Isoetes*, which latter were innumerable. Above this peaty sand were 6 or 7 feet of boulder clay, brown and rusty from being near the surface, and in it were some trap boulders 2 feet in diameter. Between these gravel and peat beds on the south side of the quarry, and the peat beds in the sandy clay in the north-east corner, there is the great gap of the quarry, and all physical connection is now wanting between them, but there can be little reasonable doubt that both are parts of the same series of deposits which took place at the same time under similar circumstances, and, taken together, they suggest a river, rapid and torrential in parts, and in others, slow, and with lake-like expansions, in the quieter water of which the shells and *Ostracoda* lived, and the plants grew, whose remains we now find buried in its peats and silts.

ANCIENT LAKE AT NEW REDHALL QUARRY.

In 1874, when this quarry was first opened, a lake peat-bed was disclosed beneath the boulder clay, and resting partly on sand lying upon the rock and partly on a lower boulder clay. A description and sketch of the section as then exposed is given by Mr J. Henderson in the *Trans. of the Geol. Soc. of Edinburgh*, vol. ii, p. 391. An attempt was made to get the plant remains found in the peat-bed named, but it was unsuccessful. At various tirrings since 1874, the same lake peat-bed was exposed, and, though further attempts were made to get the plants and other things named, nothing effective was done till 1887, when Mr Clement Reid, of the Geological Survey of England, succeeded in naming about 46 species of plants, whose names and characters will be found in his paper on the "Early History of the British Flora," published in the *Annals of Botany* for August 1888. At the same time, through the kindness of Mr Reid, the beetles found along with the seeds were submitted to Mr C. O. Waterhouse of the British Museum, who was able to name about 30 species. The samples of peat from the tiring of 1887 were got from the coup, the bed *in situ* having been rendered inaccessible by a landslip. In 1889, during another tiring, access was got to the peat-bed *in situ*, and many samples taken from different parts of the bed were subjected to improved methods of research, with results far exceeding those obtained previously. The seeds and beetles obtained, greatly surpassed in number those got before, and the record will be considerably extended. One interesting addition was a number of Ostracod shells, which come as an agreeable surprise, for it has been generally held by experienced students that these shells, which consist, partly at least, of limy matter, would be dissolved by the carbonic acid of the decaying peat, and nothing left to tell of their existence in the lakes in which the peat was formed.

The section in which the lake peat occurred in 1889 consisted of—(1.) sandy stony clay, presumably rotten boulder clay, resting on the rock; (2.) brown compressed vegetable matter 4 inches in thickness, with only a few seeds of the

bogbean and many spores of *Isoetes*. This compressed peaty layer was distinctly laminated, and seemed to consist wholly of stems of reeds. It lay partly on several large trap-boulders, and partly in the hollow spaces between them, showing that it had been deposited on an uneven bed out of which the boulders protruded. (3.) The next layer was a mud or silt, three or four inches in thickness at the north end of the section, but increasing to as many feet at the south end—only rootlets were found in several samples of it. (4.) A bed of peat about three feet in thickness in the middle of the section where it was best exposed and most typical. The peat consisted chiefly of vegetable mud or earth felted with mosses or reed stems or simple vegetable fibres, probably the compressed rootlets of plants. From being felted with these it would not dissolve or separate, and had to be crushed mechanically by the hand in water, which made the washing and separating of the seeds and other things from the matrix rather laborious, but the labour was well repaid by the extraordinary number of seeds, insect remains, chiefly beetles; and cases of caddis worms of two or three forms, one of which was in hundreds or rather thousands. Full lists of all, we hope, may form the subject of a future paper, when the identification of the whole is completed. The uppermost six inches of this bed was even more felted with mosses and reed stems, some parts consisting wholly of them cemented by a little reddish-brown mud. A small quantity of the finest portion of this mud was examined in 1887 for Diatoms by Mr R. Kidston and Dr J. Rae, R.N., who found in it about 40 species, a list of which—as determined by them—is given at page 154. Throughout the whole of this peat-bed stones were frequent, mostly sandstones and trap, but a few were of silurian grit or greywacke. (5.) Above this peat-bed stood, in section, 10 or 12 feet of stony clay, but being nearly covered by vegetation its character was not visible at a glance, though there could be little doubt it was boulder clay. Near the southern end of the peat-bed is an assemblage of waterworn boulders with gravel, resting on the rock, and it is likely that, as at Hailes, a river with quiet lake ex-

pansions existed here also during some part of the glacial period.

In conclusion we wish it to be distinctly understood, that from the furtive manner in which the material from these old lake deposits was collected, the number of Mollusca and Ostracoda given in our lists cannot be taken as exhaustive for all or any of the deposits, but tentative merely, and that new exposures of these or any other lake deposits in or around Edinburgh would likely yield more species than we have here recorded. In the division of labour connected with this paper, it should be stated that the material was collected by Mr J. Bennie, and the naming of the species and the identification of their characters was done entirely by Mr Scott.

THE "NOR' LOCH."

We were able to procure from the old bed of this loch only a small quantity of material for examination, and in it organic remains, both animal and vegetable, were fairly abundant. Among the organic remains were several species of Ostracoda,—two of which, viz., *Cypris prasina*, Fischer, and *Candona candida* (Müller), were moderately common,—and some imperfectly preserved molluscan shells.

The following are the species of Ostracoda and Mollusca from this deposit identified by us.

It may be stated that the site of the loch is about 2¼ miles from the sea, and about 150 feet above sea-level.

MOLLUSCA.

Pisidium pusillum (Gmelin). One valve.

Limnæa peregra (Müller). A few imperfect specimens.

OSTRACODA.

Cypria ophthalmica (Jurine). Rather scarce.

Cypris prasina, Fischer. Common.

Erpetocypris reptans (Baird). Rather scarce.

Candona candida (Müller), ♂ ♀. Both forms common.

„ *lactea*, Baird. Frequent.

Limnocythere inopinata (Baird). Frequent.

LACUSTRINE DEPOSIT, NORTH SIDE OF BLACKFORD HILL.

This deposit does not require any special description beyond that already given. The organic remains observed in the material examined are such as are usually found in small lochs or ponds. The remains of comparatively few Molluscs were observed. The following comprise all the species of Molluscs and Ostracods we identified in the material examined :—

MOLLUSCA.

- Pisidium fontinale* (Draparnaud). Frequent.
 „ *pusillum* (Gmelin). Very common.
Sphaerium corneum (Linné). Scarce.
Planorbis glaber, Jeffreys (*P. parvus*, Say). Rare.
Limnæa peregra (Müller). Scarce.

OSTRACODA.

- Cypria ophthalmica* (Jurine). Not common.
 „ *serena* (Koch). Common.
Cypridopsis vidua (Müller). Frequent.
Potamocypis fulva, Brady. Common.
Candona candida (Müller). Not common.
 „ *lactea*, Baird. Frequent.
 „ *pubescens* (Koch). Rare.
 „ *fabæformis* (Fischer). Frequent.
Ptyocypis gibba (Ramdohr). Scarce.
Limnocythere inopinata (Baird). Common.

LACUSTRINE DEPOSIT AT JORDANVALE.

The site of this loch is about 4 miles from the sea and about 300 feet above sea-level. Molluscan shells, especially *Limnæa peregra*, were fairly abundant in this deposit, as were also those of the more common Ostracoda. The following species have been identified :—

MOLLUSCA.

- Sphaerium corneum* (Linné). Rather scarce.
Pisidium nitidum, Jenyns. Scarce.
 „ *pusillum* (Gmelin). Common.

- Planorbis glaber*, Jeffreys. Frequent.
 „ *nautilus* (Linné). Scarce.
Limnæa peregra (Müller). Very common.
Physa fontinalis (Linné). Rare.

OSTRACODA.

- Cypria serena* (Koch). Rare.
Cypria incongruens, Ramdohr. Rare.
Erpetocypris reptans (Baird). Common.
Cypridopsis vidua (Müller). Scarce.
Potamocypris fulva, Brady. Frequent.
Candona candida (Müller). Common.
 „ *fabæformis* (Fischer). Rare.
Limnocythere inopinata (Baird). Frequent.

THE MEADOWS.

Hugh Miller has so fully described this interesting locality, that little more can be said about it than is stated in “Edinburgh and its Neighbourhood.” Molluscan shells have been observed in great abundance in the deposit, and Hugh Miller refers to at least 9 species as having been found while the meadows were being drained. One species of *Planorbis*, described by him as having “a delicate dorsal keel,” which was probably *P. complanatus*,—a species still common in Lochend and Duddingston Lochs,—we have not seen, and we have only been able to identify one species of *Limnæa*; neither have we been able to recognise *Planorbis glaber*, mentioned by R. Etheridge, jun., as having been found in this deposit.¹ Ostracod remains were not very abundant, but among those observed is *Darwinula stevensoni*, which has only recently been found as a post-tertiary fossil at Whittlesea, England.

The following are the only Scotch localities where *Darwinula* has been observed living: Loch Fell, Wigtownshire; Lochs Aber and Ruter, and White and Borean Lochs, Kirkcudbrightshire; Broom Loch, Dumfriesshire; and Loch Mack, near Oban. *Darwinula* seems to have been of frequent

¹ Trans. Geol. Soc. of Edinburgh, vol. ii., p. 223.

occurrence in the Borough Loch. The following are the Mollusca and Ostracoda observed in the material examined by us from this locality :—

MOLLUSCA.

- Pisidium nitidum*, Jenyns. Frequent.
 „ *pusillum* (Gmelin). Frequent.
Planorbis nautilus (Linné). Scarce.
Valvata cristata, Müller. Common.
 „ *piscinalis* (Müller). Common.
Limnæa peregra (Müller). Very common.

Several variations in form occurred in the last two species, and especially in the *Limnæa*.

OSTRACODA.

- Cypria serena* (Koch). Frequent.
Erpetocypris reptans (Baird). Rare.
Candona candida (Müller). Frequent.
 „ *lactea*, Baird. Rare.
Darwinula stvensoni, Brady and Robertson. Frequent.

HOLYROOD LAKE.

Though Molluscan remains were fairly abundant in this old lake deposit, only five species have been identified by us, and these are common freshwater species. Ostracoda on the other hand were numerous, both in individuals and species. No fewer than twelve species belonging to nine genera have been observed, and one species, viz., *Limnocythere sancti-patricii*, is now recorded for the first time as fossil in Scotland. The following are the species of Mollusca and Ostracoda observed by us.

NOTE.—In a paper read at a meeting of the Edinburgh Field Naturalists and Microscopical Society, in February 1888, by Messrs J. A. Johnston and J. Lindsay, on “An Ancient Lake Deposit in Queen’s Park” (here called Holyrood Lake), two species of Mollusca, not found by us—viz., *Valvata cristata* and *Planorbis nitidus*,—are recorded as having been observed in the material forming this deposit.¹

¹ See Trans. Edin. Field Natur. and Micro. Soc., vol. ii., p. 138 (Part 2).

MOLLUSCA.

- Limnæa peregra* (Müller). Frequent, but many of them fragmentary.
Planorbis glaber, Jeffreys. Scarce.
Valvata piscinalis (Müller).
Pisidium pusillum (Gmelin). Frequent often perfect.
 „ *fontinale*.

OSTRACODA.

- Cypria lævis* (O. F. Müller). Rather scarce.
 „ *serena* (Koch). Rather scarce.
Cypria incongruens, Ramdohr. Rare.
Erpetocypris reptans (Baird). Frequent.
Cypridopsis villosa (Jurine). Common.
Potamocypris fulva, Brady. Frequent.
Candona candida (Müller). Very common.
 „ *lactea*, Baird. Rather rare.
 „ *pubescens* (Koch). Rare.
Ilyocypris gibba (Ramdohr). Common.
Limnocythere sancti-patricii, Brady and Robertson.
 Frequent.
Cytheridea lacustris (G. O. Sars). Common.

CORSTORPHINE LAKE NEAR STATION.

This deposit is about 200 feet above sea-level, and 4 miles from the sea; in it Molluscan remains were abundant and in good preservation. Ostracod shells were also numerous. The following are the species of Mollusca and Ostracoda identified by us :—

MOLLUSCA.

- Pisidium fontinale* (Draparnaud). Frequent.
 „ *nitidum*, Jenyns. Frequent.
Planorbis glaber, Jeffreys. Rather common.
 „ *nautilus* (Linné). Rare.
Limnæa peregra (Linné). Very common.
 „ *truncatula* (Müller). Not common.

OSTRACODA.

- Cypria lævis* (O. F. Müller). Frequent.
Cypria incongruens, Ramdohr. Rather rare.
Erpetocypris reptans (Baird). Not very common.
Ilyocypris gibba (Ramdohr). Frequent.
Candona candida (Müller). Common.
 „ *pubescens* (Koch). Rather rare.
Cypridopsis aculeata (Lilljeborg). Rather common.
 „ *vidua* (Müller). Frequent.
 „ *villosa* (Jurine). Frequent.
Limnocythere inopinata (Baird). Frequent.

KETHYMYRE.

This deposit occurs between Burntisland and Kinghorn, and is about 150 feet above sea-level, and about three-quarters of a mile from the sea. There were few Molluscan remains in the material from this deposit, but the shells of Ostracoda—mostly valves—were fairly abundant. The following are the species observed:—

MOLLUSCA.

- Pisidium nitidum*, Jenyns. A few specimens.
Valvata piscinalis (Müller). Several specimens—some of them eroded as if they had been acted on by an acid.
Planorbis albus (Müller). Two imperfect specimens.
Limnæa peregra (Linné). A few specimens.

OSTRACODA.

- Cypria serena* (Koch). Frequent.
Erpetocypris reptans (Baird). Rare; valves only.
Ilyocypris gibba (Ramdohr). Rare; valves only.
Potamocypris fulva, Brady. Frequent; many perfect.
Candona candida (Müller). Frequent; mostly valves.
 „ *? pubescens* (Koch). Rare; a single valve.
Limnocythere inopinata (Baird). A few specimens; some perfect.

HAILES QUARRY.

The Mollusca and Ostracoda from this place were found in silt and not in marl, and were tolerably well preserved. In some parts of the bed a solid peaty mud has recently been found (1889), in which occur innumerable chitinous scales which are provisionally referred to *Daphnia*, also many small brown discs which are supposed to be the statoblasts or winter eggs of freshwater polyzoa. In the solid peaty mud of Hailes, as well as in that of Redhall, many round black shining bodies occurred, probably the cases of water mites—*Acaridæ*.

MOLLUSCA.

Pisidium fontinale (Draparnaud). A few whole valves and some fragments.

Planorbis glaber, Jeffreys. Several specimens.

Limnæa peregra (Müller). Rather scarce, and imperfect.

Vertigo pygmæa (Draparnaud). Imperfect. This has very likely been washed into the deposit from the vicinity, as it is not unusual to find this and other Vertigos beside freshwater lochs.

OSTRACODA.

Candona candida (Müller). Not common ; valves only.

Ilyocypris gibba (Ramdohr). Frequent ; valves mostly.

Cytheridea torosa (Jones), var. *teres*. Not common.

REDHALL QUARRY.

The Ostracoda were found in the solid peat mud from the upper layer of peat by the improved methods of washing recently adopted, and the number of each species is comparatively small at present, but it is expected that the continuation of these researches will yield an increased number of species as well as individuals. This record of their occurrence in peat at Redhall it is also hoped will induce research for Ostracoda in other lake peats, as, however

unlikely it may appear that the shells of Ostracods can resist decomposition, yet here we have proof that they have done so. A considerable number of the freshwater foraminifer, *Deflugia*, sp., also occurred along with the Ostracoda.

MOLLUSCA.

Pisidium pusillum (?), Gmelin. One immature specimen.

OSTRACODA.

Cypria ophthalmica (Jurine). This species was of frequent occurrence, but few were well preserved, and some had the appearance of being coated with a ferruginous dust.

„ *serena* (Koch). One or two specimens.

Cypis incongruens, Ramdohr. One specimen.

Erpetocypris olivacea (?), Brady and Norman. One specimen.

Candona rostrata, Brady and Norman. One specimen.
This is the first record of the occurrence of this species as a post-tertiary fossil, but one of the Authors has since found it in a somewhat similar deposit in Ross-shire, in moderate abundance.

Candona candida (Müller). One or two specimens.

Limnocythere inopinata (Baird). One specimen.

MOLLUSCA

Found in the various Lacustrine Deposits.

The following is a full list of the MOLLUSCAN remains observed in the various lacustrine deposits referred to in the preceding notes :—

Sphærium corneum (Linné).

Pisidium fontinale (Draparnaud).

„ *pusillum* (Gmelin).

„ *nitidum*, Jenyns.

Valvata piscinalis (Müller).

„ *cristata*, Müller.

Planorbis nautilus (Linné).

„ *albus*, Müller.

„ *glaber*, Jeffreys.

Physa fontinalis (Linné).

Limnæa peregra (Müller).

„ *truncatula*? (Müller).

Vertigo pygmæa (Draparnaud).

The following is a full list of the OSTRACOD remains observed in the various lacustrine deposits referred to in the preceding notes. As considerable changes have quite recently been made in the nomenclature of the Ostracoda, and especially of the fresh and brackish water species, we have considered it advisable to add a synonymy sufficiently full to enable those not conversant with this group to more easily recognise the various forms referred to.

OSTRACODA

Found in the various Lacustrine Deposits.

Family CYPRIDIDÆ.

Cypria ophthalmica (Jurine).

Cypria,
Zenker.

Monoculus ophthalmicus, Jurine, Hist. des Monocles, p. 178, pl. xix., figs. 16, 17.

Cypria compressa, Baird, Trans. Berw. Nat. Club, vol. 1, p. 100, pl. iii., fig. 16.

„ *compressa*, Brady, Mon. rec. Brit. Ostrac., 372, pl. xxiv., figs. 1-5; pl. xxxvi., fig. 6.

Cypria ophthalmica, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 69, pl. xi., figs. 5-9 (1889).

Cypria lævis (O. F. Müller).

Cypria lævis, Müller, Entom., p. 52, pl. iii., figs. 7-9.

„ *minuta*, Baird, Brit. Entom., p. 155, p. xviii., figs. 7, 8.

„ *ovum*, Brady, Mon. rec. Brit. Ostrac., p. 373, pl. xxiv., figs. 31-34, 43-45; and pl. xxxvi., fig. 8.

Cypria lævis, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 69 (1889).

Cypria serena (Koch).

Cypria serena, Koch, Deutschlands Crustaceen, H. xxi., 22.

„ *laevis*, Brady, Mon. rec. Brit. Ostrac., p. 374, pl. xxiv., figs. 6-8.

Cypria serena, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 70 (1889).

Cypria,
Müller.

Cypris incongruens, Ramdohr.

Cypris incongruens, Ramdohr, Ueber die Gattung Cypris; der naturforsch. Freunde zu Berlin Magazin, 2 Jahrg 1808, p. 86.

„ *aurantia*, Baird, Brit. Entom., p. 159, tab. xiv., fig. 13.

„ *incongruens*, Brady, Mon. rec. Brit. Ostrac., p. 362, pl. xxiii., figs. 16-22 (1868).

„ *incongruens*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 73, pl. xii., figs. 8, 9 (1889).

Cypris prasina, Fischer.

Cypris strigata, Baird, Brit. Entom., p. 157 (1850), (*non* Müller).

„ *prasina*, Fischer, Beitrag zur Kenntniss der Ostracoden, p. 644, pl. xix., figs. 9-13 (1855).

„ *salina*, Brady, Mon. rec. Brit. Ostrac., p. 368, pl. xxvi., figs. 8-13 (1868).

„ *prasina*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 78 (1889).

Erpetocypris reptans (Baird).

Erpetocy-
pris, Brady
and Norman.

Candona reptans, Baird, Brit. Entom., p. 167 (1850).

„ *similis*, Baird, *loc. cit.*, p. 162, pl. xix., figs. 2, 2a (*pullus*).

Cypris reptans, Brady, Mon. rec. Brit. Ostrac., p. 370, pl. xxv., figs. 10-14; pl. xxxvi., fig. 4 (1868).

Erpetocypris reptans, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 84, pl. xiii., fig. 27 (1889).

Erpetocypris olivacea (?), Brady and Norman.

Erpetocypris olivacea, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 89, pl. i., figs. 3, 4 (1889).

Cypridopsis vidua (Müller).

Cypridopsis,
Brady.

Cypris vidua, Müller, Entom., p. 55.

Cypridopsis vidua, Brady, Mon. rec. Brit. Ostrac., p. 375, pl. xxiv.,
figs. 27-36, 46 (1868).

„ *obesa*, Brady and Robertson, Ann. Nat. Hist., ser. iv.,
vol. iii., p. 364, pl. xviii., figs. 5-7 (1869).

„ *vidua*, Brady and Norman, Mon. M. and Fw. Ostrac.
of the N. Atlantic and N.-W. Europe, p. 84, pl. xiii.,
fig. 27 (1889).

Cypridopsis aculeata (Lilljeborg).

Cypris aculeata, Lilljeborg, De Crust. ex-ord. trib., p. 117.

Cypridopsis aculeata, Brady, Mon. rec. Brit. Ostrac., p. 376,
pl. xxiv., figs. 16-20; pl. xxxvi., fig. 10 (1868).

„ *aculeata*, Brady and Norman, Mon. M. and Fw.
Ostrac. of the N. Atlantic and N.-W. Europe, p. 90
(1889).

Cypridopsis villosa (Jurine).

Monoculus villosa, Jurine, Hist. des Monocles, p. 178.

Cypris westwoodii, Baird, Brit. Entom., p. 156.

? *Cypris elongata*, Baird, loc. cit., p. 156.

Cypridopsis villosa, Brady, Mon. rec. Brit. Ostrac., p. 377, pl. xxiv.,
figs. 11-15; pl. xxxvi., fig. 9 (1868).

„ *villosa*, Brady and Norman, Mon. M. and Fw. Ostrac.
of the N. Atlantic and N.-W. Europe, p. 90 (1889).

Potamocypris fulva, Brady.

Potamocy-
pris, Brady.

Bairdia fulva, Brady, Mon. rec. Brit. Ostrac., p. 474, pl. xxviii.,
fig. 21 (1868).

Potamocypris fulva, Brady, Nat. Hist. Trans. Northum. and
Durham, p. 366, pl. xiv., fig. 4 (1870).

„ *fulva*, Brady and Norman, Mon. M. and Fw. Ostrac.
of the N. Atlantic and N.-W. Europe, p. 93, pl.
xxii., figs. 13-17 (1889).

Candona candida (Müller).

Candona,
Baird.

Cypris candida, Müller, Entom., p. 62, tab. vi., figs. 7-9.

Candona lucens, Baird, Brit. Entom., p. 160, tab. xix., fig. 1.

„ *candida*, Brady, Mon. rec. Brit. Ostrac., p. 383, pl. xxv.,
figs. 1-9; pl. xxxvi., fig. 13; and pl. xxxvii., fig. 1
(1868).

Candona candida, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 98, pl. x., figs. 1, 2, and 14-23 (1889).

***Candona lactea*, Baird.**

Candona lactea, Baird, Proc. Zool. Soc. Lond., p. 255, pl. xviii., figs. 25-27.

„ *detecta*, Müller, Entom., p. 49, tab. iii., figs. 1-3.

„ „ Brady (var.), Mon. rec. Brit. Ostrac., p. 384, pl. xxiv., figs. 35-38 ; pl. xxxvii., fig. 2 (1868).

„ *lactea*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 100 (1889).

***Candona pubescens* (Koch).**

Cypris pubescens, Koch, Deutschlands Crustaceen, H. 11, p. 5 (1837).

„ *setigera*, Jones, Mon. Tert. Entom., p. 12, pl. i., figs. 6a-6d.

Candona compressa, Brady, Mon. rec. Brit. Ostrac., p. 382, pl. xxvi., figs. 22-27 (1868).

„ *albicans*, Brady, loc. cit., p. 381, pl. xxv., figs. 20-25 ; pl. xxxvi., fig. 12 (1868). (Junior.)

„ *pubescens*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 101, pl. xii., figs. 32-37 (1889).

***Candona rostrata*, Brady and Norman.**

Candona rostrata, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 101, pl. ix., figs. 11, 12, 12a and b ; pl. xii., figs. 22-31 (1889).

Cypris compressa, Fischer, Ueber das genus *Cypris*, p. 144, pl. ii., figs. 7-12 ; pl. iii., figs. 1-5 (1851).

***Candona fabæformis* (Fischer).**

Cypris fabæformis, Fischer, Ueber das genus *Cypris*, p. 146, pl. iii., figs. 6-16 ♀ ♂ (1851).

Candona diaphana, Brady and Robertson, Ann. and Mag. Nat. Hist., ser. iv., vol. iv., p. 18, pl. v., figs. 1-3 ♀ (1870).

„ *fabæformis*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 103, pl. ix., figs. 1-4 ♀ ♂ (1889).

Ilyocypris gibba (Ramdohr).

Ilyocypris,
Brady and
Norman.

Cypris gibba, Ramdohr, Mag. und Gesellsch. naturforsch. Freunde zu Berlin, ii, p. 91.

„ „ Brady, Mon. rec. Brit. Ostrac., p. 369, pl. xxiv., figs. 47-54; pl. xxxvi., fig. 2 (1868).

Ilyocypris gibba, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 107, pl. xxii., figs. 1-5 (1889).

Family DARWINULIDÆ.

Darwinula stevensoni, B. and R.

Darwinula,
Brady and
Robertson.

Polychæles stevensoni, B. and R., Ann. and Mag. Nat. Hist., ser. iv., vol. vi., p. 25, pl. vii., figs. 1-7; pl. x., figs. 4-14 (1870).

Argillæcia aurea, B. and R., Ann. and Mag. Nat. Hist., ser. iv., vol. vi., p. 16, pl. viii., figs. 4, 5 (1870).

Darwinella stevensoni, B. and R., *ibid.*, ser. iv., vol. ix., p. 50 (1872).

Darwinula stevensoni, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 123, pl. x., figs. 7-13; pl. xiii., figs. 1-9; pl. xxiii., fig. 5 (1889).

Family CYTHERIDÆ.

Limnocythere inopinata (Baird).

Limnocythere
Brady.

Cythere inopinata, Baird, Brit. Entom., p. 172, pl. xx., figs. 1, 1a-1e.

Limnocythere inopinata, Brady, Mon. rec. Brit. Ostrac., p. 419, pl. xxix., figs. 15-18 (1868).

„ *inopinata*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 170 (1889).

„ *inopinata*, Brady and Norman, *loc. cit.*, pl. xvii., figs. 18, 19.

Limnocythere sancti-patricii, Brady and Robertson.

Limnocythere sancti-patricii, B. and R., Ann. and Mag. Nat. Hist., ser. iv., vol. iii., p. 17, pl. xviii., figs. 8-11; pl. xxi., fig. 4 (1869).

„ *sancti-patricii*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 171, pl. xvii., figs. 1, 2 (1889).

cytheridea,
osquet.

Cytheridea lacustris (G. O. Sars).

Cythere lacustris, G. O. Sars, Zool. Reise i Sommeren, 1863, p. 30.

Cytheridea lacustris, Brady, Mon. rec. Brit. Ostrac., p. 427,
pl. xxvi., figs. 18-21; pl. xl., fig. 2 (1868).

„ *lacustris*, Brady and Norman, Mon. M. and Fw.
Ostrac. of the N. Atlantic and N.-W. Europe,
p. 176 (1889).

Cytheridea torosa (Jones), var. *teres*.

Candona torosa, Jones, Ann. and Mag. Nat. Hist. (ii.), vol. vi.,
p. 27, pl. iii., fig. 6.

Cytheridea torosa, Brady, Mon. rec. Brit. Ostrac., p. 425, pl. xxviii.,
figs. 7-12; pl. xxxix., fig. 6.

„ *torosa*, Brady and Norman, Mon. M. and Fw. Ostrac.
of the N. Atlantic and N.-W. Europe, p. 175
(1889).

TABLE I.

SHOWING DISTRIBUTION OF *Mollusca* MENTIONED
IN THE PRECEDING NOTES.

NAMES OF SPECIES.	Distribution in Ancient Lake Deposits here referred to.								Distribution (Living) in the Vicinity of Edinburgh.
	The "Nor Loch."	Blackford Hill.	Jordonvale.	The Meadows.	Holyrood.	Corstorphine.	Kethymyre.	Redhall.	
<i>Sphaerium</i> <i>corneum</i> (Linné), .		•	•						{ Lochend Loch; Canal, near Gil- more Place. Pond near Blackford Hill, and Union Canal.
<i>Pisidium</i> <i>fontinale</i> (Drap.),		•				•		•	
„ <i>pusillum</i> (Gmel.),	•	•	•	•	•			•	{ Canal, near Gilmore Place. Pond near Blackford Hill, <i>f.d.</i>
<i>nitidum</i> , Jenyns,			•	•		•	•		
<i>alvata</i> <i>piscinalis</i> (Müll.),				•			•		{ Duddingston Loch; Union C'n'l. Small Loch at Corstorphine, <i>c.</i>
<i>cristata</i> , Müller, .				•					
<i>Planorbis</i> <i>nautilus</i> (Linné),			•	•		•			{ Duddingston Loch, <i>f.</i> Canal, near Gilmore Place, <i>f.</i> Not known to occur in the district.
„ <i>albus</i> , Müller, .			•			•	•		
„ <i>glaber</i> , Jeffreys, .		•	•		•	•		•	{ Duddingston Loch, <i>c.</i>
<i>Physa</i> <i>fontinalis</i> (Linné),			•						
<i>Limnæa</i> <i>peregra</i> (Müll.), .	•	•	•	•	•	•	•	•	{ Duddingston; Dunsappie; Blackford, <i>f.d.</i> Beside Water of Leith, near the Dean Bridge. Salisbury Crag, <i>f.</i>
„ <i>truncatula</i> , .						•			
<i>Vertigo pygmaea</i> , .									

TABLE II.

SHOWING DISTRIBUTION OF THE *Ostracoda* MENTIONED
IN THE PRECEDING NOTES.

NAMES OF SPECIES.	Distribution in Ancient Lake Deposits here referred to.								Recent in Britain.			Distribution (Living) in the Vicinity of Edinburgh.	
	The "Nor' Loch."	Blackford Hill	Jordonvale.	The Meadows.	Holyrood.	Corstorphine.	Kethymyre.	Redhall.	Halca.	England.	Scotland.	Ireland.	The following Abbreviations are used : <i>c.</i> = common ; <i>f.</i> = frequent ; <i>r.</i> = rare ; <i>f.d.</i> = frequent throughout the district.
Cypridids.													
<i>Cypris</i>													
<i>ophthalmica</i> , . . .	*	*			*	*		*		*	*	*	Dud'gston Loch, <i>f.</i>
<i>laevis</i> , . . .										*	*	*	Duddingston Loch.
<i>serena</i> (Koch), . .		*	*	*	*		*	*		*	*	*	{ Duddingston Loch; Corstorphine, <i>f.d.</i>
<i>Cypris</i>													
<i>incongruens</i> , . . .			*		*		*	*		*	*	*	{ P'bello Brickfields, abundant, <i>f.d.</i>
<i>prasina</i> , . . .	*									*	*	*	{ Not yet observed living in vicinity.
<i>Erpetocypris</i>													
<i>reptans</i> , . . .	*		*	*	*	*	*			*	*	*	{ Duddingston Loch; Corstorphine, <i>f.d.</i>
<i>olivacea</i> , . . .								*					Dud'gston Loch, <i>f.</i>
<i>Cypridopsis</i>													
<i>vidua</i> , . . .		*	*							*	*	*	Duddingston Loch.
<i>aculeata</i> , . . .						*				*	*	*	{ Not yet observed living in vicinity.
<i>villosa</i> , . . .					*	*				*	*	*	Duddingston Loch.
<i>Potamocypris</i>													
<i>fulva</i> , . . .		*	*		*	*	*		*	*	*	*	{ Duddingston Loch; Corstorphine, <i>f.d.</i>
<i>Candona</i>													
<i>candida</i> , . . .	*	*	*	*	*	*	*	*	*	*	*	*	{ Duddingston Loch, <i>f.d.</i>
<i>lactea</i> , . . .	*	*	*	*	*	*	*	*	*	*	*	*	{ Duddingston Loch; Loanhead, <i>f.</i>
<i>pubescens</i> , . . .		*			*	*	*			*	*	*	Duddingston Loch;
<i>rostrata</i> , . . .								*		*	*	*	Portobello.
<i>fabaeformis</i> }													Dud'gston Loch, <i>f.</i>
(<i>Fischer</i>), }	*	*								*	*	*	{ Duddingston Loch; Corstorphine, <i>f.</i>
<i>Ilyocypris</i>													
<i>gibba</i> (Ramdohr),	*				*	*	*		*	*	*	*	{ Duddingston Loch; Loanhead; P'bello.
Darwinulids.													
<i>Darwinula</i>													
<i>Stevensoni</i> , Brady }				*						*	*	*	{ Not found living in the vicinity.
and Robertson, }													
Cytherids.													
<i>Limnocythere</i>													
<i>incipinata</i> (Baird)	*		*			*	*	*		*	*	*	Dud'gston Loch, <i>f.</i>
<i>sancti-patricii</i> , }						*				*	*	*	{ Not yet observed living in vicinity.
B. & R., }													
<i>Cytheridea</i>													
<i>lacustris</i> (G. O. }										*	*	*	Union Canal.
Sars), }													
<i>torosa</i> , . . .									*	*	*	*	{ Brackish - water pools on the shore, Aberlady, <i>c.</i>

**DIATOMS FROM INTERGLACIAL PEAT-BED IN BOULDER CLAY,
REDHALL QUARRY, NEAR EDINBURGH.**

Amphora ovalis, Ktz.
Ceratoneis arcus, Ktz.
 „ „ var. *majus*.
Cymbella lanceolata, Ehr.
 „ *cistula*, Hemper.
 „ *gastroides*, Ktz.
 „ „ var. *minor*.
Stauroneis phanicerteron, Nitz.
 „ *acuta*, W. Sm.
 „ *gracilis*, W. Sm.
 „ *anceps*, Ehr.
Navicula major, Ktz.
 „ *nobilis*, Ktz.
 „ *viridis*, Ktz.
 „ *gibba*, Ktz.
 „ *linosa*, Ktz.
 „ *ovalis*, Sm.
 „ *anglica*, Ralfs.
 „ *radiosa*, Ktz.
 „ *cuspidata*, Ktz.
 „ *rhynchocephala*, Ktz.

Navicula, sp.
Pleurosigma attenuatum, W. Sm.
Gomphonema insigne, Grev., forma
major.
Epithemia gibba, Ehr.
 „ „ var. *ventricosa*.
Asterionella formosa, Hassal.
Synedra pulchella, Ktz.
 „ *danica*, Ktz.
Tabellaria fenestrata, Lyngb.
Cymatopleura solea, Sm.
 „ *elliptica*, Breb.
Surirella elegans, Ehr.
 „ *spiralis*, Ktz.
 „ *biseriata*, Breb.
Campylodiscus costatus, W. Sm.
Nitzschia angustata, Gran.
Hantzia amphioxys, var. *intermedia*,
 Grun.
Cyclotella comte, Ktz.

Note.—I have no doubt that further investigations would increase the list of diatoms from this bed.—R. K.

**XVI. Notes on a few Crustacea and Mollusca new to the Fauna
of the Forth, with Exhibition of Specimens. By THOMAS
SCOTT, Esq., F.L.S.**

I.

(Read 20th February 1889.)

The Scientific Committee of the Scottish Fishery Board have kindly agreed to allow me to exhibit the following specimens to the Society :—

SCHIZAPODA.

Previous to the summer of 1887, four species of Schizapods were known to occur in the Firth of Forth, viz.: *Boreophausia raschii*, M. Sars; *Nyctiphanes norvegica*, M. Sars; *Macropsis slabberi*, Van Ben.; and *Mysis flexuosa*, Müller. H. Goodsir described one or two forms, but the descriptions and figures are not precise enough to enable those forms to

be ascribed to any known species. Through the investigations carried on by the Fishery Board thirteen additional species of Schizapods have been added to the Forth fauna. Nine of these are recorded in the Board's Report published last year. The species which I now exhibit have been observed since that Report was published. They are as follows:—

Mysidopsis didelphys, Norman.

Mysis didelphys, Norman, Dredging Report, Trans. Tyne Nat. F. Club, vol. v., p. 270, pl. xii., figs. 9-12.

Mysidopsis didelphys, G. O. Sars, Mon. over de ved Nor. Kyster forekommende Mysider, part ii., p. 20, pl. vii. (1872).

This appears to be a rare species in the Forth. I observed it among some tow-net material collected near Fidra during November last.

Erythrops goëssii, G. O. Sars,—new to Britain.

Mysis erythrophthalma, Goës, Crust. Decap. mar. Svec., p. 18.

Erythrops goëssii, G. O. Sars, Mon. over de ved Nor. Kyster forekommende Mysider, part i., p. 24, pl. i. (1870).

I find this species frequent all over the Forth from Inchkeith to the May Island, as well as outside the May. How it happens to have escaped observation hitherto may not be easily explained. Another species, *E. pygmaea*, G. O. Sars, which I first observed in East Loch Tarbert, Loch Fyne, was also new to Britain. A third species, *E. serratus*, G. O. Sars, was discovered by Dr A. M. Norman among the Shetland Islands. They are all small, but easily recognised, when living, by their bright red eyes. The eyes turn whitish after being kept in spirit awhile.

Leptomysis gracilis, G. O. Sars.

Mysidopsis hispida, Norman, Report Brit. Assoc. for the Advancement of Science, 1868, p. 267.

Leptomysis gracilis, G. O. Sars, Mon. over de ved Nor. Kyster forekommende Mysider, part iii., p. 31, pls. xix., xx (1879).

Several specimens of this species have been observed among tow-net material collected to the east of Inchkeith. Previous Scotch records for it are the Moray Firth and the Shetland Islands.

Heteromysis formosa, Smith.

Described by Professor Smith for the United States. I noticed this species in some tow-net material collected to the east of Inchkeith during October last year. Dr A. M. Norman informs me that he procured two specimens of this species at Guernsey in 1856, and that he knows of no other British habitat for it than the two now recorded. This species comes very near *Heteromysis* (*Chiromysis*) *microps*, G. O. Sars.

COPEPODA.

Cymbasoma rigidum, J. C. Thompson.

I observed two specimens of this among tow-net material collected to the east of Inchkeith. Both of them, Mr Thompson tells me, were females. Unfortunately he found it necessary to dissect them, so that I have only the dissected parts to exhibit. Mr Thompson has the following records of its distribution, viz.: the Canary Islands, the Mediterranean, Jersey (Channel Islands), Lamlash Bay, Arran, Clyde, and Loch Linnhe. It does not appear to have been previously noticed on the east coast of Scotland.

II.

(Read 20th March 1889.)

MOLLUSCA.

Stilifer turtoni, Broderip.—Two living specimens found by Miss Janet Carphin (grand-daughter of the late Principal Cunningham) on an *Echinus* brought by one of the Newhaven fishing boats from near the Isle of May on March last (1888).

Clio borealis, Brug = *Clione papilionacea*, Pallas.—The specimen now exhibited was captured by me near Inchkeith in January last.

XVII. *Notes on the Larval Stages of Motella.* By GEORGE BROOK, Esq., F.L.S. [Plate VI.]

(Read 16th March 1887.)

On the afternoon of September 24th, 1886, I was fortunate enough to meet with a large shoal of larval fishes, which

subsequently proved to be young forms of *Motella cimbria*. Our yacht had just dropped anchor in Whiting Bay, on the east shore of the Island of Arran, and we were preparing to make some tow-nettings. The sea was extremely calm, and as the hour was shortly before sundown, I expected a rich gathering of forms at the surface. Whilst preparing for work, a large number of larval fishes were seen to be playing at the surface all around the yacht, and as they darted away from us the water appeared to be glittering all over with silvery streaks. I hastily concluded they were young herring, and a large number were at once secured and placed in a carboy filled with sea water. As we extended our observations further and further away from the yacht, we had a good opportunity of watching the movements of the young fishes. They were evidently feeding on the shoals of copepoda and larval crustacea, which I presumed to be present, and which were subsequently revealed by means of the tow-net. Indeed, the sea was so calm at the time, that the only motion of its surface appeared to be caused by living organisms. The smaller species of copepoda were of course indistinguishable from the dingly, but larger forms, such as *Anomalocera Patersoni* and *Calanus finmarchicus*, were readily observed in the water. A curious broad and intermittent ripple was caused by a larger crustacean, which proved on examination to be the young of the lobster. One or two species of amphipods and an annelid were also noted at the surface, whilst in the tow-nets we obtained a rich and varied gathering. An examination of our collection of larval fishes showed at a glance that I had been too hasty in supposing them to be herring fry. The specimens varied from $\frac{3}{4}$ to $1\frac{1}{4}$ inches in length. The colour of the ventral surface was a brilliant silver, which gradually faded into a greenish-black towards the dorsal aspect. The outline was relatively short and thick, and the majority of the specimens had enormous fan-like ventrals, which at once recalled Agassiz's drawings of the larval stages of *Motella argentea*. In order if possible to identify the species, a large number of the fry were kept alive until we reached Rothesay, and were then transferred

to the Aquarium. As it was advisable to keep the specimens under constant observation, the large tanks of the establishment were considered unsuitable, and the majority of the fry were placed in a series of wood hatching-troughs similar to those used for trout ova. A few were also placed in a glass jar, in order that their habits might be watched. Having given instructions for the proper feeding of the fry, I left Rothesay for two or three days. On my return I was much disappointed to find that the whole of the specimens placed in the wood troughs had died, whilst there had scarcely been a death amongst those placed in the glass jar. This was a severe lesson, and showed clearly the unsuitability of wood hatching-boxes for marine forms. For fresh-water fishes they serve very well, but unless coated with asphalte or some similar substance, I have frequently found them to prove fatal to delicate marine embryos. Those in the glass jar lived well for some time, but there were occasional deaths. The young fry fed freely on copepods, and the smaller forms of amphipods. At first they swam near the surface, and always looked upwards for food. They could not be induced to take food at the bottom for several weeks. Later, as the fan-like ventrals became more and more reduced, they began to rest more at the bottom, until a time arrived when they ceased to feed in the former manner, and now always searched the bottom of the jar for food. There appears little doubt that this change in habit is a natural one, associated with a change in food, in which case the large larval ventrals must be of especial use, and enable the embryo more readily to maintain itself near the surface of the sea during the period when its natural food is to be found there. A similar pelagic habit is, however, common to the larvæ of most marine fishes irrespective of the condition of the ventral fins, and all feed at first on small pelagic organisms. The specimens were so far advanced by Christmas, that the species could be recognised, and by the end of February one specimen had assumed all the characters of the adult, and measured nearly $2\frac{1}{2}$ inches in length.

The species to which they belonged—*Motella cimbria*—is usually regarded as one of the rarest of the British *Motellæ*,

and although it appears to occur all around the Scottish coast, it is, so far as I am aware, not numerous in any district. The occurrence of a large shoal of larvæ off the coast of Arran is therefore of especial interest. The fry of the various species of *Motella* are known in the south of England as *mackerel-midges*, probably owing to the fact that mackerel and other predaceous fishes prey upon them. Day¹ states that they occur in shoals from March to June, often at a considerable distance from land. The genera *Ciliata* of Couch, and *Couchia* of Thompson, are founded on these immature forms; whilst Günther's *Hypsiptera* is an allied form. Lütken refers it to the genus *Phycis*, and more recently Emery² has supposed Günther's form to be the young of *Phycis mediterranea*.

The larval stages of an American species of *Motella* (*M. argentea*) have been studied by Alexander Agassiz,³ who has published an excellent series of drawings of immature specimens varying from 4 to 34 mm. in length. The earlier stages of development have also been studied by Agassiz and Whitman⁴ and myself.⁵

The newly-hatched embryos of *Motella* are about 2.15 mm. in length, and are pigmented in a characteristic manner, for the details of which I must refer to the works already cited. At this time the paired fins exist only in rudiment, but the pectorals soon grow more rapidly than the ventrals, and expand into relatively large rounded transparent organs a few days after hatching. The ventrals, on the other hand, are at first relatively small and narrow, and soon become pigmented. One of the most interesting points connected with the life history of *Motella* is the enormous development of the ventrals into larval swimming organs, and their later reduction to the normal type.

¹ Day, *Fishes of Great Britain and Ireland*, vol. i., p. 312.

² Emery, *Contribuzioni all' Ittiologia*; xv. *Phycis mediterranea*—Mitth. Zool. Stat. Nap., Bd. vi., p. 159, pl. x., fig. 25.

³ Agassiz, A., *Young Stages of Oseous Fishes*, pt. iii.—*Proc. Amer. Acad. Sci.*, vol. xvii., pp. 294-296, pl. vii., and pl. viii. figs. 1-3.

⁴ Agassiz and Whitman, *Development of Oseous Fishes*, pt. i.—*Mem. Mus. Comp. Zool.*, vol. xiv., pp. 39-43, pl. xviii., figs. 1-6.

⁵ Brook, *Development of Motella mustela*—*Journ. Linn. Soc., Zool.*, vol. xviii., pp. 298-307, pls. viii.-x.

The following table shows the relative length (in millimetres) of the head, pectoral and ventral fins, in larvæ of various sizes, to which the measurements in the adult of *M. cimbria* and in very early embryos of *M. mustela* are added for comparison:—

Species.	Total Length.	Length of Head.	Length of Pectorals.	Length of Ventrals.
<i>M. mustela</i> (newly-hatched embryo),	2.15 ¹	...	.08	...
„ (4½ days),	2.3	.43	.34	.12
<i>M. cimbria</i> ,	5.0–6.0	1.6–1.7	0.7	2.0
„	8.0–9.0	2.0–2.5	1.0–1.2	2.5
„	11.0–12.7	2.7–3.0	1.3–1.9	3.0
„	14.5–15.5	3.3–3.5	2.1–2.3	3.5
„	17.5–19.3	3.7–4.2	2.5–3.0	4.5–4.7
„	20.0–23.0	4.2–4.7	3.0–3.2	4.0
„	30.0	6.0	4.5	4.2
„	31.5	7.0	4.8	4.5
<i>M. cimbria</i> (adult),	280	49	35	23

It will be seen from the table that the ventral fins must undergo an exceedingly rapid development shortly after the embryo is hatched. In *Motella mustela* at the time of hatching the ventrals are only recognisable as a faint ridge. Four or five days afterwards they are about .12 mm. long, and form simple, oval, deeply-pigmented organs, which are apparently still without rays. In the smallest larvæ of *M. cimbria* which have come under my notice, the ventrals are relatively very large, and have a length equal to a third of that of the whole embryo. They form fan-like organs supported by four stout rays, all of which are similar in length. At this stage the relative length of the ventrals is greatest, and in later stages the fins become reduced in breadth, whilst at the same time the rays are relatively more

¹ The length of the newly-hatched embryo of *Motella mustela* is incorrectly given as 2.25 mm. in my paper on that species already referred to. The measurements taken at the time show a variation between 2.118 and 2.17 mm.

slender. As the larvæ gradually assume the specific characters, the lower rays of the ventrals appear to undergo a partial atrophy, and assume the relative length characteristic of the adult (*cf.* Pl. VI., Figs. 3 and 4).

The period at which the various barbels are developed appears to correspond with the order of their phylogenetic origin. The first to appear is that on the lower jaw, and a stage is thus reached which represents the adult condition in many Gadidæ. This barbel is as yet undeveloped in larvæ of *Motella cimbria*, 9 mm. long; it was first noticed as a distinct papilla in larvæ of 11 mm. The two lateral barbels of the snout are next developed, and in the species under consideration arise as small papillæ, which were first noticed in larvæ of 12·5 mm. This stage represents the adult condition in *Motella tricirrata* and *Motella macrophthalmia*. Finally the median barbel of the snout is recognisable as a faint tubercle in larvæ of 20 mm., and is well marked in larvæ of 30 mm. Thus the adult condition is reached, and it is only after the formation of this fourth barbel that the identity of the species is established.

EXPLANATION OF PLATE VI.

Fig. 1. Larvæ of *Motella cimbria*, 5·3 mm. long; lateral view.

Fig. 2. The same specimen seen from above.

Fig. 3. Later larvæ 17·5 mm. long, showing reduction in the larval ventrals and the barbel on the lower jaw.

Fig. 4. Young *Motella cimbria*, 31·5 mm. long, showing the specific characters.

XVIII. *Notes on the British Species of Lepadogaster, and on the Development of the Vertical Fins.* By GEORGE BROOK, Esq., F.L.S., F.R.S.E. [Plate VII.]

(Read 18th April 1888.)

It has long been admitted that the species of *Lepadogaster* are subject to considerable variation, particularly in colour, and a number of forms described as distinct are now regarded merely as varieties. Day, in his work on the "Fishes of Great Britain and Ireland," recognises only three species. He says

(vol. i, p. 189):—"There appear to be only three specific forms, and these are subject to almost endless modifications as to colour. They may be recognised as follows:—

"A. *Dorsal fin continuous with the caudal.*

a. Dorsal fin with more than ten rays, . . . *L. Gouanii.*

"B. *Dorsal fin not continued on to the caudal.*

a. Dorsal fin with more than ten rays (14-16), . . . *L. Decandolii.*

b. Dorsal fin with less than eight rays (5-7), . . . *L. bimaculatus.*"

Saville Kent, in his "British Marine and Freshwater Fishes,"¹ refers to a form which he regards as a fourth British species of the genus, a type which has been regarded by Couch and others as a variety of *L. bimaculatus*. It occurs in the Channel Islands, and also on the Devonshire and Cornish coasts. I am not aware that Saville Kent has given a detailed diagnosis of his species, and the following characters are collected from the general account of the genus in the work already referred to (pp. 54-56):—

Lepadogaster Couchii, Saville Kent. — General ground colour variable; the two lateral ocelli, distinctive of *L. bimaculatus*, are never developed, "but in lieu of this a single very conspicuous dark-coloured streak is developed along each side of the head, the eye being stationed immediately in its centre and interrupting it at this point. . . . Important structural differences are found to exist in the composition of the dorsal, anal, and caudal fins, and more especially in that of the ventral acetabulum. Finally, it is found to affect a different habitat, for while *L. bimaculatus* is to be obtained only with the aid of the dredge at some little distance from the shore, the form here introduced is a strictly littoral species, obtainable beneath stones in the rock-pools at all ordinary ebb-tides." It is much to be regretted that the structural differences referred to have not been more precisely stated.

In my endeavours to identify the specimens of *Lepadogaster* which I have from time to time obtained on the west

¹ Handbook issued in connection with the International Fisheries Exhibition, London, 1883.

coast of Scotland, I have frequently noticed the occurrence of a form which differs considerably from any of the species described in Day's standard work, although, like Kent's *L. Couchii*, it comes closest to *L. bimaculatus*. I have no certain means at present of deciding whether Kent's species and my own are identical, but if so, the description of the former omits the chief points which I regard as of specific value. The following notes have been compiled from a comparison of west coast specimens with those of the Channel Islands and the Mediterranean. I am indebted to Professor M'Intosh of St Andrews for the loan of a few specimens from Guernsey; and Mr Sinel has supplied me with a number of Jersey specimens.

1. LEPADOGASTER GOUANII, Lacép.

Day gives the following fin-formula:—D., 16-20; P., 20-25; V., $1\frac{1}{4}$; A., 9-11; C., 19. Dorsal and anal continuous with the caudal. In the specimens which I have examined the formula is D., 15-18; A., 10-12; C., 19-23. The dorsal fin appears usually to consist of 17 or 18 rays, the anal of 10 or 11, whilst in the caudal the average is 21. The latter consists usually of 14 well-developed rays, with a variable number of slender and more rudimentary ones at the upper and lower margins. Apparently owing to the fact that the part of the continuous embryonal fin immediately preceding the caudal is not absorbed in this species, there is a tendency for rudimentary rays to be developed beyond the usual limits of the caudal; but as these are directed backwards they form no support to the dorsal or anal, and should probably be regarded as supplementary caudal rays. The head is flat beneath, and in shape resembles a half cone. The breadth is usually $\frac{1}{10}$ ths of the length, reckoned from the tip of the snout to the posterior margin of the operculum. The snout is relatively long and spatulate; the nasal filaments are always well marked. The general colour is extremely variable, but carmine or purplish red usually predominates. Three small specimens sent to me by Mr Sinel from Jersey were quite black, with white margins to the fins. These, after being in spirit for some time, showed the two deep

spots behind the eyes which appear characteristic of the species. In the sixteen specimens which I have examined, chiefly from the Channel Islands, the caudal fin was invariably rounded. The operculum is rounded posteriorly, and has no marked spinous process as in *L. Decandolli*.

This species is common in the Channel Islands, but does not appear frequent around the Scottish coast, although several specimens have been recorded from various localities. I have obtained a single specimen from the Sound of Kilbrannan in 8 to 10 fathoms.

2. *L. DECANDOLLI*, Risso.

Day gives the following fin-formula :—D., 14-16; P., 25; V., $1\frac{1}{4}$; A., 8-11; C., 18. The dorsal and anal fins reach nearly to the caudal, but are not continuous with it. In the specimens which have come under my notice, the variations of the vertical fins are only slight, viz.:—D., 14-15; A., 10-11; C., 18-19. The head is much flattened, but the upper contour is not arched as in *L. Gouanii*. A thick fleshy ridge projects above the premaxilla, which is more marked than in any other species. The width of the head is $\frac{1}{10}$ ths, and the height $\frac{2}{10}$ ths of its total length. The operculum bears a distinct spinous process, which varies somewhat in position. In Mediterranean specimens it is situated near the lower border of the operculum; in a Scotch specimen the posterior margin gradually tapers to a sharp point, which is more nearly central in position. The membranous portion of the unpaired fins is thick and somewhat fleshy, so that the fins stand out well in specimens preserved in spirit. The whole skin appears to be thicker and looser in this species than in *L. Gouanii* or *L. bimaculatus*. The general colour is more or less red, but the markings are extremely variable, and none of them appear to be constant.

A fine specimen of this species over 3 inches in length was obtained between tide marks near Tarbert, Lochfyne, in February 1886. This, so far as I am aware, is the first record of its occurrence in Scottish waters. The species is

common in the Mediterranean, and extends to the Channel Islands, Cornwall, and the West Coast of Ireland.

3. *L. BIMACULATUS*, DONOV.

Day gives the following fin-formula:—D., 5-7; P., 17; V., 5; A., 4-6; C., 12. From a comparison of specimens from the Mediterranean, Channel Islands, and West Coast of Scotland, I have obtained the following formula:—D., 6; A., 5; C., 19-21. It is curious that eight or nine specimens from such different localities should agree in having the same number of rays in the dorsal and also in the anal. No doubt a certain variation might be observed by a comparison of a larger number of specimens, but one appears justified in pointing out that there is usually one ray more in the dorsal fin than in the anal. It should be noted that the whole of the specimens included in the above summary have the two lateral ocelli from which the species derives its name (*cf.* Pl. VII., Fig. 6). It seems probable that the specimens without the pair of lateral or rather latero-ventral ocelli may not come under the species as here defined. I have not seen any specimens from the English Channel which do not appear referable to the species under consideration, but it is well known that unspotted specimens have hitherto been included in it, and it is apparently for such types that Saville Kent has suggested the name *L. Couchii*.

With regard to the number of rays composing the caudal fin, in which my observations differ considerably from those of Day, I have usually found 20 rays. Twelve to fourteen of these are strong, whilst three or four at both the dorsal and ventral margins are short and slender. All the species of the genus appear to agree in this respect, but the relative development of the marginal rays varies considerably in the different types.

In addition to the fin-formula which I have already noted, typical *L. bimaculatus* may be distinguished from other species of the genus, and particularly from *L. microcephalus*, by the following characters:—(1.) The relatively broad and short head, the width of which is $\frac{1}{4}$ ths to $\frac{2}{3}$ ths of the length—

Day says 3rds; (2.) the short fusiform and *rapidly* tapering body; (3.) the unusual delicacy of the membrane connecting the rays of the vertical fins, which may never be described as robust or fleshy, and is certainly more delicate than that of any other British species; (4.) the usual, if not invariable, presence of the paired latero-ventral ocelli; (5.) the rounded posterior margin of the operculum. I should, however, state that in two of the specimens from Guernsey, which Professor M'Intosh has kindly lent me, the head is not so wide as usual, but the fins, both in the number of their rays and in their general delicacy, agree with typical specimens.

This species is generally distributed around the British Islands, but, so far as my experience goes, it is not frequent in Scottish waters, and it is possible that a number of the specimens already on record may belong to the form next described. I have obtained it off Ardnamurchan and also in the Gairloch in 8 to 12 fathoms. It has also been dredged off Colonsay by my friend Mr W. L. Calderwood.

4. *L. MICROCEPHALUS*, n. sp.

? *L. Couchii*, Saville Kent.

The following is the formula of the vertical fins:—D., 5; A., 6; C., 17-19.

This form bears a general resemblance to *L. bimaculatus*, but may be distinguished by the following characters:—(1.) the skin is thick and loose as in *L. Decandolli*; (2.) the membrane of the vertical fins is more rigid, and there is a special fleshy thickening at the anterior extremity of the dorsal, and also, though usually less marked, at the anterior margin of the anal; (3.) the anal fin consists of one ray more than the dorsal, whilst the reverse is the case in *L. bimaculatus*; (4.) the caudal usually contains 10 to 11 prominent rays, instead of 12 to 13 as in *L. bimaculatus*; (5.) the head is relatively narrow, its width being equal to about two-thirds of the length; (6.) the trunk is relatively more elongate, and tapers *gradually* to the tail (*cf.* PL VII., Figs. 4 and 6); (7.) the median disc of the ventral acetabulum is narrower, and its lateral margins are nearly straight;

(8.) the posterior margin of the operculum instead of being rounded is distinctly angular, and is continued into a spinous process; (9.) the paired latero-ventral ocelli appear to be invariably absent; (10.) the general body colour is usually a dirty greenish-brown without any very prominent markings, but dredged specimens generally have a reddish hue, which becomes paler towards the ventral surface. It will be seen that many of the features which distinguish this species from the preceding are characters which it shares in common with *L. Decandolli*. Such are the condition of the skin, the rigidity of the fins, the shape of the posterior margin of the operculum, etc. This is by far the most abundant species on the West Coast of Scotland, and appears to be generally distributed. I have obtained it between tide-marks in Rothesay Bay and in Lochfyne. I have also obtained it by means of the dredge in the Firth of Lorne (10 to 15 fathoms), and as far north as Loch Boisdale (3 to 4 fathoms). Saville Kent thinks his form is a truly littoral species and that in this respect it differs from *L. bimaculatus*. I cannot say whether the species just described is the same as that referred to by Saville Kent, but my observation tends to show that *L. microcephalus* usually frequents the off-shore waters. In certain districts large numbers of this species come inshore in the early summer, apparently to spawn, and they may then be taken in numbers between tide-marks, but it is equally certain that for nine or ten months out of the twelve, in the same localities, not a single specimen is to be found.

Development of the Vertical Fins.

In September 1887 I obtained a few larval forms of *L. microcephalus* in Loch Boisdale, together with two or three adult specimens. They vary from 7 to 9 mm. in length, and show an interesting stage in the development of the vertical fins. The continuous embryonal fin still exists in larvæ of 7 mm. (*cf.* Pl. VII., Fig. 1). In larvæ of 9 mm. (Pl. VII., Fig. 2) the embryonal fin is divided up into dorsal, caudal, and anal. It will be seen from the figure that the part of the embryonal fin which is later absorbed, remains at this

stage applied to the caudal. It is probably in this part that the imperfect supplementary rays of the caudal are developed, which are particularly well seen in some specimens of *L. Gouanii*.

EXPLANATION OF PLATE VII.

Fig. 1. Larva of *L. microcephalus* 7 mm. long, showing the continuous embryonal fin.

Fig. 2. Larva of *L. microcephalus* 9 mm. long, showing the fin divided into dorsal, caudal, and anal, together with the remnant of the intermediate portions applied to the caudal.

Fig. 3. *L. microcephalus*, lateral view.

Fig. 4. *L. microcephalus*, ventral view.

Fig. 5. *L. Gouanii*, showing the nasal filament, and the two characteristic dark spots behind the eye.

Fig. 6. *L. bimaculatus*, ventral view, showing the characteristic outline of the head and trunk and the paired latero-ventral ocelli.

XIX. Note by WILLIAM EVANS, Esq., F.R.S.E., on a Specimen of the Red-footed Falcon (*Falco vespertinus*, L.), exhibited by him at the Meeting of the Society, held 20th February 1889.

Instances of the capture of the Red-footed Falcon in Scotland are so rare, that the specimen exhibited is believed to be but the third on record. It was shot on 21st June 1888, near Swinside, a few miles from Jedburgh, and taken the following day to Mr Robert Hope, birdstuffer, there, who kindly sent it up for exhibition.¹ It is a male, as was proved by dissection, probably just entering its second year. Mr Hope states that its stomach was filled with the remains of beetles. The mixture of the plumages of the immature and adult state, presented by the specimen, is very interesting; and as I cannot call to mind any figure or description coinciding with it, I give here the following details:—Upper part of head, bluish-grey or lead colour, darkest on the cheeks, the shaft of each feather darker, imparting to the plumage a finely streaked appearance: back of neck, pale reddish-brown or ferruginous: sides of neck, chin, and throat, greyish-white: back, scapulars, middle and lesser wing coverts, and upper

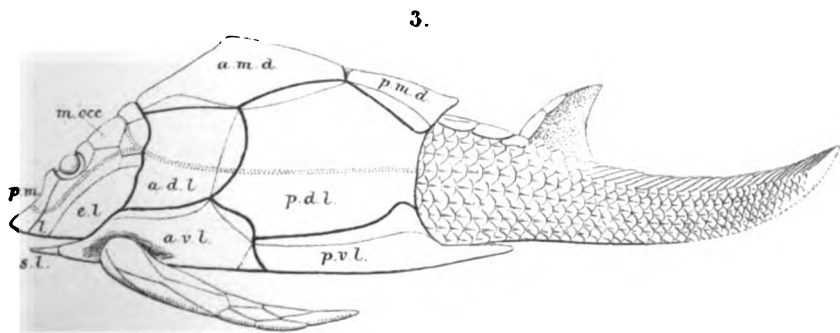
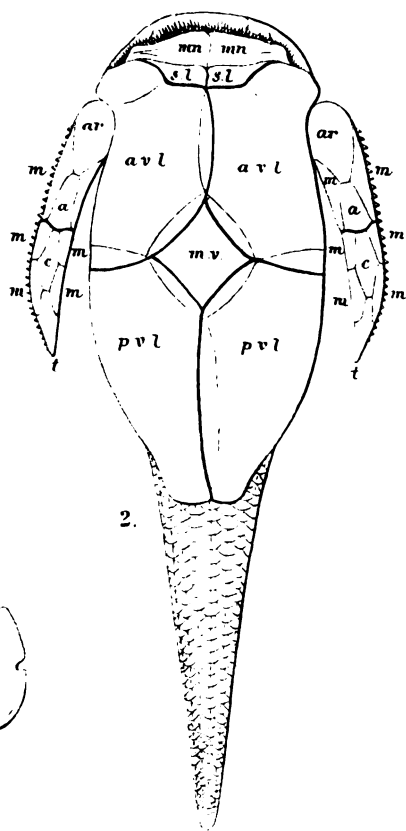
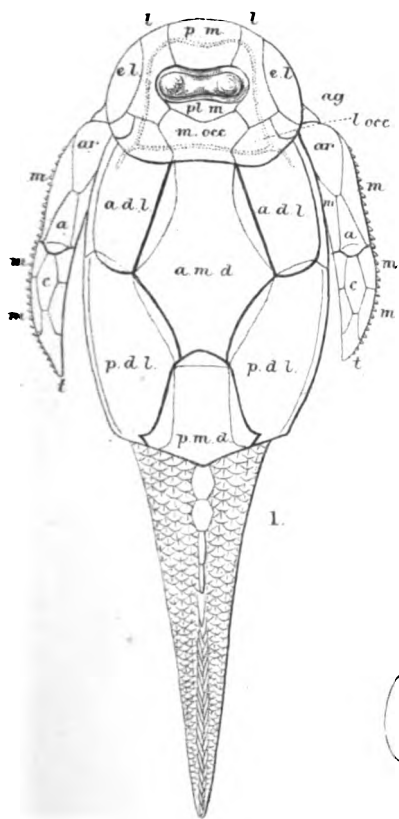
¹ Since the specimen was exhibited, it has been acquired by the Edinburgh Museum of Science and Art.

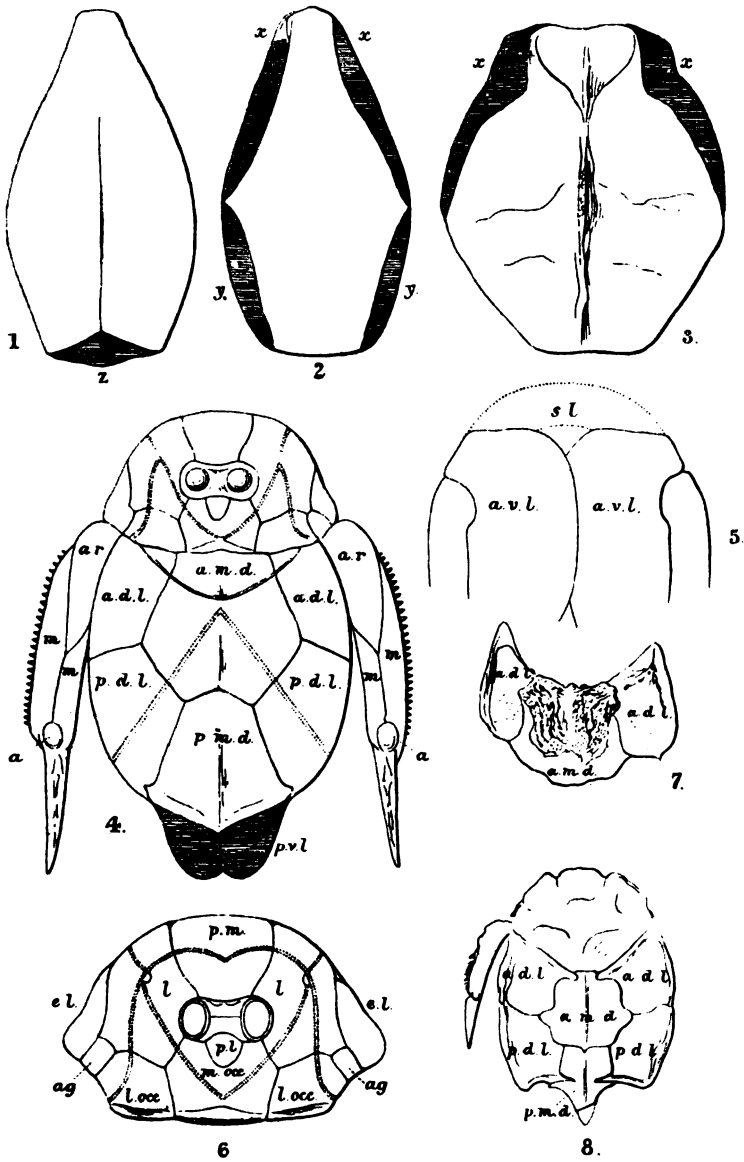
tail coverts, bluish-grey, with a few of the barred buff-coloured feathers of immaturity still showing themselves here and there : secondaries consisting entirely of worn feathers of first plumage, pale brown, with darker bars : primaries, and most of their coverts, well worn, and apparently not moulted, dull bluish-black, the primaries with large whitish spots on inner webs : rump, clothed mainly with the pale ferruginous, dark-barred feathers of immaturity, intermixed with which are a few of the new slate-coloured feathers : tail feathers, twelve in number, all, except second outer on right, and second and third on left, dark lead-colour, with still darker broad bar near the apex, and mostly quite new and perfect ; the second on right, and second and third on left, are those of immaturity, much worn, dull white, suffused with ferruginous, and crossed with dark leaden bars : scarcely any of the primaries or rectrices show the slightest trace of the pale terminal margins seen in the newly acquired first plumage : breast, belly, and thighs, rich ferruginous or bay, mixed with pale bluish-grey : under tail coverts, paler bay : little if any trace of the first plumage exists on the under parts.

PLATE I.

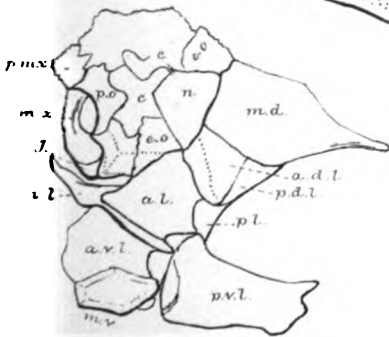
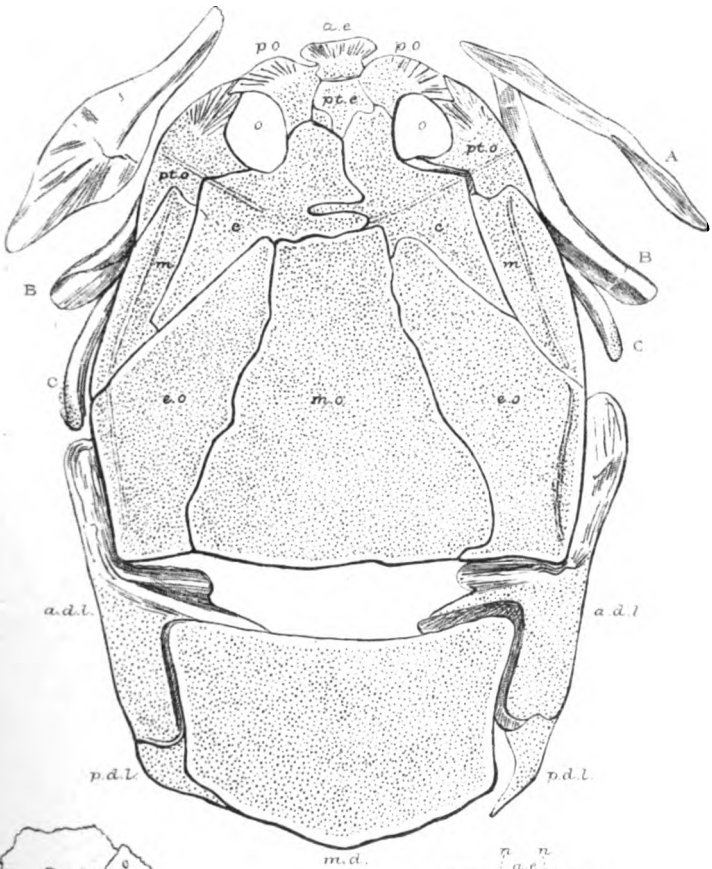
Vol. X

Royal Physical Society, Edinburgh.

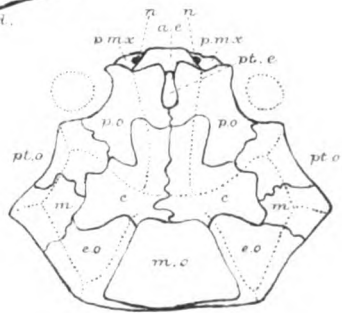




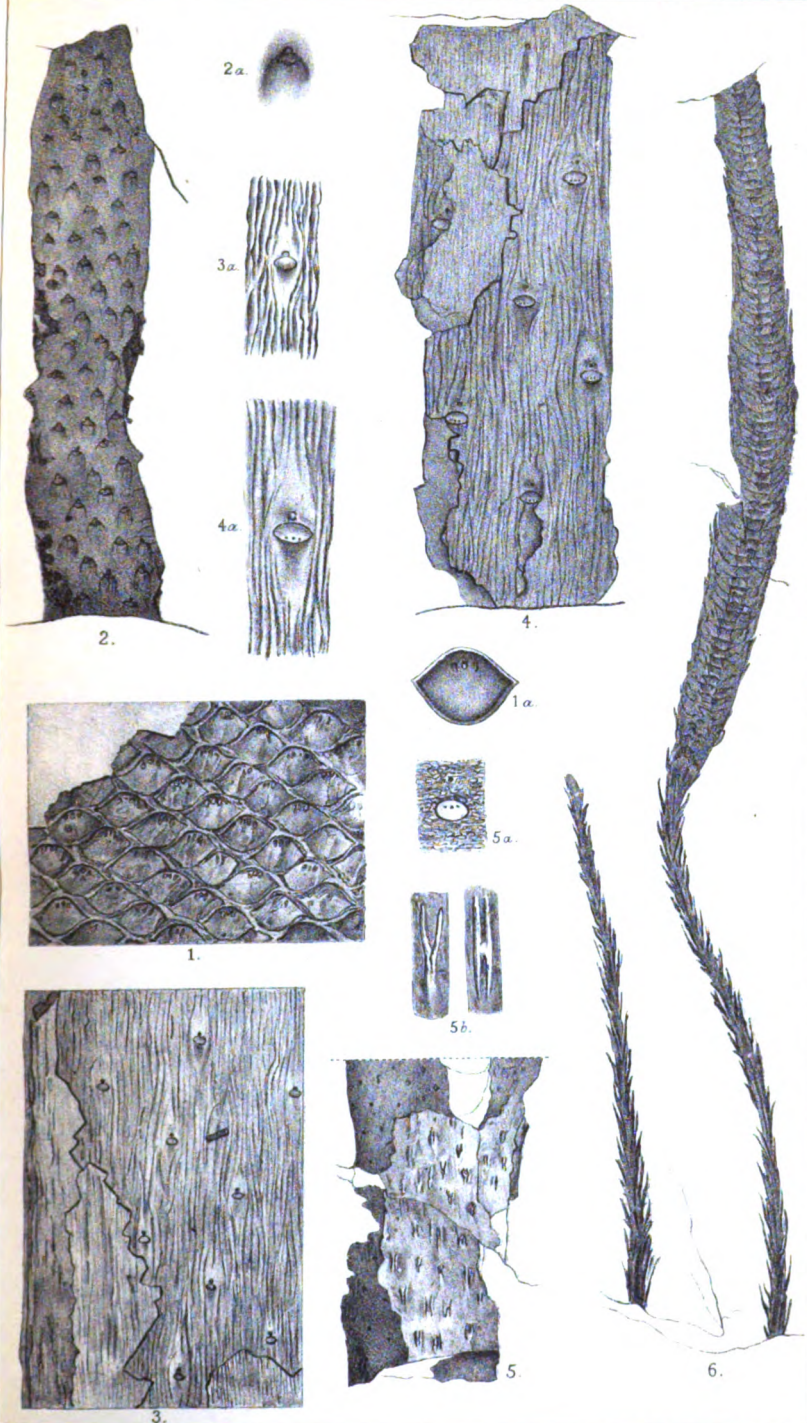
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3



2



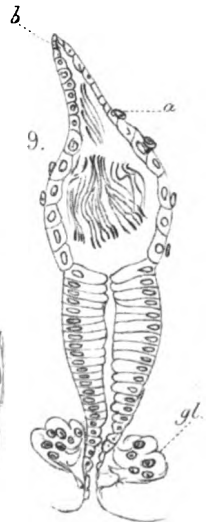
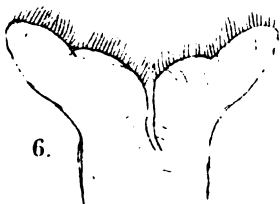
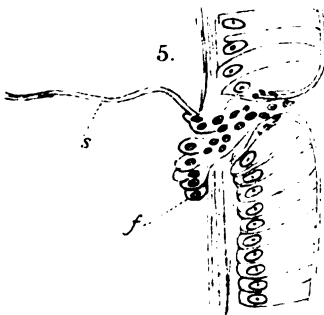
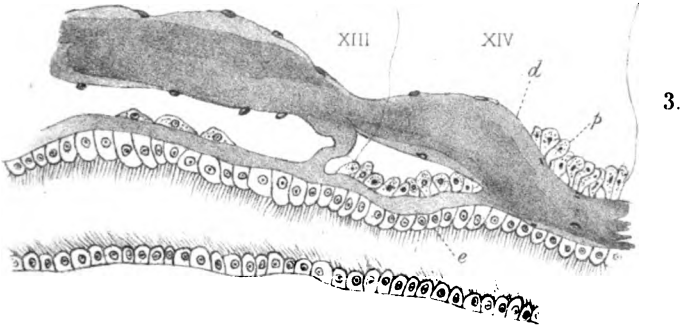
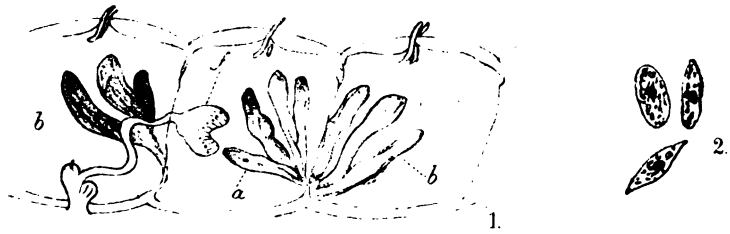


Fig. 1.

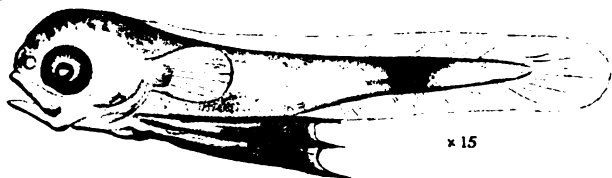


Fig. 2.

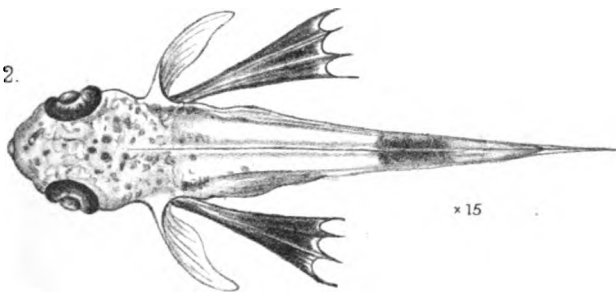


Fig. 3.

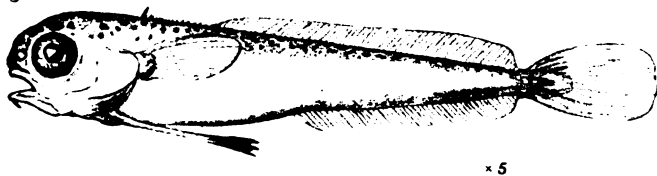


Fig 4



Fig. 1.



x 6

Fig. 2.



x 6

Fig. 5.



x 1 1/2

Fig. 3.



x 1 1/2

Fig. 4.



x 1 1/2

Fig. 6.



x 1 1/2

PROCEEDINGS
OF THE
ROYAL PHYSICAL SOCIETY.

SESSION CXIX.

Wednesday, 20th November 1889.—Dr R. H. TRAQUAIR, F.R.S.,
President, in the Chair.

Professor J. GEIKIE, LL.D., D.C.L., F.R.S., retiring Vice-President, delivered the following opening address :

One of the most interesting questions with which geological science has to deal is that of the evolution of climate. Although there is no general agreement as to how former climatic fluctuations came about, yet the prevalent opinion is that in the past, just as in the present, the character of the climate must have depended mainly on latitude and the relative position of the great land- and water-areas. This was the doctrine taught by Lyell, and its cogency none will venture to dispute. It is true he postulated a total redistribution of oceans and continents—a view which the progress of science has shown to be untenable. We can no longer speculate with him on the possibility of all the great land-areas having been grouped at one time round the equator, and at some other period about the poles. On the contrary, the evidence goes to show that the continents have never changed places with the ocean—that the dominant features of the earth's crust are of primeval antiquity, and antedate the oldest of the fossiliferous formations. The whole ques-

tion of climatic changes, therefore, must be reconsidered from the point of view of the modern doctrine of the permanency of continental and oceanic areas.

But before proceeding to this discussion, it may be well to glance for a moment at the evidence from which it has been inferred that the climate of the world has varied. Among the chief proofs of climatic fluctuations are the nature and distribution of former floras and faunas. It is true that fossils are, for the most part, relics of extinct forms, and we cannot assert of any one of these that its environment must have been the same as that of some analogous living type. But, although we can base no argument on individual extinct forms, it does not follow that we are precluded from judging of the conditions under which a whole suite of extinct organisms may have lived. Doubtless, we can only reason from the analogy of the present; but, when we take into account all the forms met with in some particular geological system, we seem justified in drawing certain conclusions as to the conditions under which they flourished. Thus, should we encounter in some great series of strata many reef-building corals, associated with large cephalopods and the remains of tree-ferns and cycads, which last from their perfect state of preservation could not have drifted far before they became buried in sediment, we should surely be entitled to conclude that the strata in question had been deposited in the waters of a genial sea, and that the neighbouring land likewise enjoyed a warm climate. Again, should a certain system, characterised by the presence of some particular and well-marked flora and fauna, be encountered not only in sub-tropical and temperate latitudes but also far within the Arctic Circle, we should infer that such a flora and fauna lived under climatic conditions of a very different kind from any that now exist. The very presence, in the far north, of fossils having such a geographical distribution, would show that the temperature of polar seas and lands could not have been less than temperate. When such broad methods of interpretation are applied to the problems suggested by former floras and faunas, we seem compelled to conclude that the conditions

which determined the distribution of life in bygone ages must have been, upon the whole, more uniform and equable than they are now. It is unnecessary that I should go into detailed proof; but I may refer, by way of illustration, to what is known of the Silurian and Carboniferous fossils of the Arctic regions. Most of these occur also in the temperate latitudes of North America and Europe, while many are recognised as distinctive types of the same strata nearly all the world over. As showing how strongly the former broad distribution of life-forms is contrasted with their present restricted range, Professor Heilprin has cited the Brachiopoda. Taking existing species and varieties as being 135 in number, he remarks that "there is scarcely a single species which can be said to be strictly cosmopolitan in its range, although not a few are very widely distributed; and, if we except boreal and hyperboreal forms, but a very limited number whose range embraces opposite sides of the same ocean. On the other hand, if we accept the data furnished by Richthofen concerning the Chinese Brachiopoda, we find that out of a total of thirteen Silurian and twenty-four Devonian species, no less than ten of the former and sixteen of the latter recur in the equivalent deposits of Western Europe; and, further, that the Devonian species furnish eleven, or nearly 50 per cent. of the entire number, which are cosmopolitan or nearly so. Again, of the twenty-five Carboniferous species, North America holds fully fifteen, or 60 per cent., and a very nearly equal number are cosmopolitan." The same palæontologist reminds us that by far the greater number of fossils which occur in the Palæozoic strata of Australia are present also in regions lying well within the limits of the north temperate zone. "In fact," he continues, "the relationship between this southern fauna and the faunas of Europe and North America is so great as to practically amount to identity."

But, side by side with such evidence of broad distribution, we are confronted with facts which go to show that, even at the dawn of Palæozoic times, the oceanic areas at all events had their more or less distinct life-provinces. While many of the old forms were cosmopolitan, others were

apparently restricted in their range. It would be strange, indeed, had it been otherwise; for, however uniform the climatic conditions may have been, still that uniformity was only comparative. An absolutely uniform world-climate is well-nigh inconceivable. All we can maintain is that the conditions during certain prolonged periods were so equable as to allow of the general diffusion of species over vastly greater areas than now; and that such conditions extended from low latitudes up to polar regions. Now, among the chief factors which in our day determine the limitation of faunas and floras, we must reckon latitude and the geographical position of land and water. What, then, it may be asked, were the causes which allowed of the much broader distribution of species in former ages?

It is obvious that before a completely satisfactory answer to that question can be given, our knowledge of past geographical conditions must be considerably increased. If we could prepare approximately correct maps and charts to indicate the position of land and sea during the formation of the several fossiliferous systems, we should be able to reason with some confidence on the subject of climate. But, unfortunately, the preparation of such correct maps and charts is impossible. The data for compilations of the kind required are still inadequate, and it may well be doubted whether, in the case of the older systems, we shall ever be able to arrive at any detailed knowledge of their geographical conditions. Nevertheless, the geological structure of the earth's crust has been so far unravelled as to allow us to form certain general conceptions of the conditions that must have attended the evolution of our continents. And it is with such general conceptions only that I have at present to deal.

I said a little ago that the question of geological climates must now be considered from the point of view of the permanency of the great dominant features of the earth's crust. I need not recapitulate the evidence upon which Dana and his followers have based this doctrine of the primeval antiquity of our continental and oceanic areas. It is enough if I remind you that by continental areas

we simply mean certain extensive regions in which elevation has, upon the whole, been in excess of depression; by oceanic area, on the other hand, is meant that vast region throughout which depression has exceeded elevation. Thus, while the area of permanent or preponderating depression has, from the earliest geological times, been occupied by the ocean, the continental areas have been again and again invaded by the sea—and even now extensive portions are under water. It is not only the continental dry land, therefore, but all the bordering belt of sea-floor which does not exceed 1000 fathoms or so in depth, that must be included in the region of dominant elevation. Were the whole of this region to be raised above the level of the sea, the present continents would become connected so as to form one vast land-mass, or continental plateau.

All the sedimentary strata with which we are acquainted have been accumulated over the surface of that great plateau, and consequently are of comparatively shallow-water origin. They show us, in fact, that at no time in geological history has that plateau ever been drowned in depths at all comparable to those of the deeper portions of our oceanic troughs. The stratified rocks teach us, moreover, that the present land-areas have been gradually evolved, and that, notwithstanding many oscillations of level, these areas have continued to increase in extent—so that there is probably more land-surface now than at any previous era in the history of our globe. To give even a meagre outline of the evidence bearing upon this interesting subject is here impossible. All that I can do is to indicate very briefly some of the general results to which that evidence seems to lead.

The oldest rocks with which we are acquainted are the so-called Archæan schists.¹ But these have hitherto yielded no unequivocal traces of organic life, and as their origin is still doubtful, it would obviously be futile to speculate upon the geographical conditions of the earth's surface

¹ I need hardly remind geologists that some of the so-called "Archæan schists" may really be the highly altered accumulations of later geological periods.

at the time of their formation. Reliable geological history only begins with the fossiliferous strata of the Palæozoic era. From these we learn that in the European area the Archæan rocks of Britain, Scandinavia, and Finland formed, at that time, the most extensive tract of dry land in our part of the world. How far beyond the present limits of Europe that ancient northern land extended, we cannot tell; but it probably occupied considerable regions which are now submerged in the waters of the Arctic Ocean. Further south, the continental plateau appears to have been, for the most part, overflowed by a shallow sea, the surface of which was dotted by a few islands of Archæan rocks, occupying the sites of what are now some of the hills of Middle Germany and the Archæan districts of France and the Iberian Peninsula. Archæan rocks occur likewise in Corsica and Sardinia, and again in Turkey, and they also form the nuclei of most of the great European mountain-chains, as the Pyrenees, the Alps, the Carpathians, and the Urals. These areas of crystalline schists may not, it is true, have existed as islands at the beginning of Palæozoic times, for they were doubtless ridged up by successive elevations at later dates; but their very presence as mountain-nuclei is sufficient to show that at a very early geological period, the continental plateau could not have been covered by any great depth of sea. We can go further than this,—for all the evidence points to the conclusion that, even so far back as Cambrian times, the dominant features of the present European continent had been, as it were, sketched out. Looked at broadly, that part of the great continental plateau upon which our European lands have been gradually built up may be said to be traversed from west to east by two wide depressions, separated by an intervening elevated tract. The former of these depressions corresponds to the great Central Plain which passes through the south of England, north-east of France, and the Low Countries, whence it sweeps through Germany, to expand into the extensive low grounds of central and northern Russia. The southern depression embraces the maritime tracts of the Mediterranean, and the regions which that sea covers. To these dominant

features all others are of subordinate importance. The two great troughs are belts of depression in the continental plateau itself. The northern one is of extreme antiquity—it is older, at all events, than the Cambro-Silurian period. Even at that distant date, its southern limits were marked out by ridges of Archæan rock, which, as I have said, seem to have formed islands in what is now Central Europe. It was probably always the shallower depression of the two, for we have evidence to show that again and again, in Mesozoic and later times, the sea that overflowed what are now the central lowlands of Europe, was of less considerable depth than that which occupied the Mediterranean trough.

If we turn to North America, we find similar reason to conclude with Professor Dana that the general topography of that region had likewise been foreshadowed as far back as the beginning of the Palæozoic era. Dana tells us that even then the formation of its chief mountain-chains had been commenced, and its great intermediate basins were already defined. The oldest lands of North America were built up, as in Europe, of Azoic rocks, and were grouped chiefly in the north. Archæan masses extend over an enormous region, from the shores of the Arctic Ocean down to the great lake country, and they are seen likewise in Greenland and many of the Arctic islands. They appear also in the long mountain-chains that run parallel with the coast-lines of the continent. In a word, the present distribution of the Archæan rocks, and their relation to the overlying strata, leads to the belief that in North America, just as in Europe, they form the foundation-stones of that continent, and stretch continuously throughout its whole extent.

We know comparatively little of the geology of the other great land-masses of the globe, but from such evidence as we have, there is reason to believe that these in their general structure have much the same story to tell as Europe and North America. In South America, Archæan rocks extend over vast areas in the east and north-east, and reappear in the lofty mountain-chains of the Pacific border. They have been recognised also in various parts of Africa, alike in the

north and east, in the interior, and in the west and south. In Asia, again, they occupy wide areas in the Indian Peninsula ; they are well developed in the Himalaya, while in China and the mountains and plateaux of Central Asia, azoic rocks, which are probably of Archæan age, are well developed. The crystalline schists, which cover extensive tracts in Australia and in the northern island of New Zealand, have also been referred to the same age. Thus all the world over, Archæan rocks seem to form the surface of the ancient continental plateau upon which all other sedimentary strata have been accumulated. And in every region where Palæozoic rocks occur, we have evidence to prove that at the time these last were formed vast areas of the old continental plateau were under water.

The geological structure of the Palæozoic tracts of Europe and America has shown us that, during the protracted period of their accumulation, and notwithstanding many oscillations of level, the land-surface continued to increase. The same growth of dry land characterised Mesozoic and Cainozoic times,—the primeval depressions that traverse the continental plateau, became more and more silted up, and the sea eventually disappeared from extensive regions which it had overflowed in Palæozoic ages. This land-growth, of course, was not everywhere continuous. Again and again, throughout wide tracts, depression was in excess of sedimentation and elevation. Even at the present time, broad tracts of what was once dry land are submerged. But the simple fact that the younger fossiliferous strata do not extend over such wide areas as the older systems, is sufficient proof that our land-masses have all along tended to grow, and to become more and more consolidated.

Reference has already been made to the remarkable fact that no abysmal accumulations have yet been detected amongst the stratified rocks of the earth's crust. Ordinary clastic rocks, such as shale, sandstone, and conglomerate—altered or unaltered, as the case may be—form by far the largest proportion of our aqueous strata, and speak to us only of shallow waters. It is true that some of our limestones must have accumulated in moderately deep clear seas,

yet none of these limestones is of abysmal origin. They prove that portions of the continental plateau have now and again been submerged for several thousand feet, but afford no evidence of depths comparable to those of the present oceanic basins. The enormous thickness attained by the sedimentary strata can only be explained on the supposition that deposition took place over a gradually sinking area. And thus it can be shown that, within the continental plateau, movements of depression have been carried on more or less continuously during vast periods of time—and yet so gradually, that sedimentation was able to keep pace with them. Take, for example, the Cambrian strata of Wales and Shropshire—all, apparently, shallow water deposits—which attain a thickness of 30,000 feet, or thereabout; or the Silurian strata of the same regions, which are not much less than 20,000 feet thick; and similar great depths of sedimentary rocks might be cited from North America. Passing on to later periods, we find like evidence of long-continued depression in the thick sediments of the younger Palæozoic systems. It is noteworthy, however, that when we come down to still later ages, the movements of depression, as measured by the depths of the strata, appear to have become less and less extensive and profound. Each such movement of depression was eventually brought to a close by one or more movements of upheaval—slowly or more rapidly effected, as the case may have been. Here, then, we are confronted with the striking fact that the continental plateau has, from time to time, sunk down over wide areas to depths exceeding those of existing oceans, and yet at so slow a rate, that sedimentation prevented the depressed regions from becoming abysmal. It is obvious, then, that such areas are now dry land simply because, in the long run, sedimentation and upheaval have been in excess of depression.

And yet, notwithstanding the numerous upheavals which have taken place over the continental plateau, these have succeeded in doing little more than drain away the sea more or less completely from the great primeval depressions by which that plateau is traversed. If it be true, therefore, that the continental plateau owes its existence to the sinking

down of the earth's crust within the oceanic basins—if the continents have been squeezed up by the tangential thrusts exerted by the sinking areas that surround them—then it follows that while lands have been gradually extending over the continental plateau, the bed of the ocean has been sinking to greater and greater depths.

If this general conclusion holds good, it is obvious that the oceanic troughs of early geological times could not have been so deep as they are now. During the Palæozoic period, the most continuous areas of dry land, as we have seen, were distributed over the northern parts of our hemisphere, while, further south, groups of islands indicated the continuation of the continental plateau. Doubtless South America, Africa, Asia, and Australia were, at that distant date, represented by similar detached areas of dry land. In a word, the primeval continental plateau was still largely under water. Judging from the character and broad distribution of the Palæozoic marine faunas, the temperature of the sea was wonderfully uniform. There is certainly nothing to indicate the existence of such climatic zones as those of the present. We know very little of the terrestrial life of early Palæozoic times—the Cambro-Silurian strata are essentially marine. Land-plants, however, become more numerous in the Old Red Sandstone, and, as every one knows, they abound in the succeeding Carboniferous and Permian systems. And the testimony of these floras, points to the same conclusion as that furnished by the marine faunas. The Carboniferous floras of the Arctic regions, and of temperate Europe and America, not only have the same *facies*, but a considerable number of the species are common to both areas; while many European species occur in the Carboniferous strata of Australia and other distant lands. This common *facies*, and the presence of numerous cosmopolitan forms, surely indicate the former prevalence of remarkably uniform climatic conditions. The conditions, of course, need not—indeed, could not—have been absolutely uniform. At present the various climates which our globe experiences depend upon the amount of heat received directly and indirectly from the sun—oceanic and aerial currents everywhere modifying the

results that are due to latitude. It cannot have been otherwise in former times. In all ages the tropics must have received more direct sun heat than temperate and Polar regions: and however much the climatic conditions of the Palæozoic era may have differed from the present—however uniformly temperature may have been distributed—still, as I have said, absolute uniformity was impossible. It was doubtless owing to the fact that the dry lands of Palæozoic times were not only much less extensive than now, but more interrupted, straggling, and insular, that the climate of the globe was so equable. Under such geographical conditions, great oceanic currents would have a much freer course than is now possible, and warm water would find its way readily across wide regions of the submerged continental plateau into the highest latitudes. The winds blowing athwart the land would everywhere be moist and warm, and no such marked differences of temperature, such as now obtain, would distinguish the Arctic seas from those of much lower latitudes. At the same time, the comparatively shallow water overlying the submerged areas of the continental plateau would favour the distribution of species, and thus bring about that wide distribution of cosmopolitan forms and general similarity of *facies*, which are such marked features of the Palæozoic faunas. It is even quite possible that migration may have taken place here and there across the great oceanic depression itself; for it may well be doubted whether, at so early a period, that depression had sunk down to its present depth below the level of the continental plateau.

Yet, notwithstanding such facilities for migration, and the consequent similarity of *facies* I have referred to, the Palæozoic faunas of different regions have usually certain distinctive characters. Even at the very dawn of the era the marine faunas were already grouped into provinces, sometimes widely separated from one another, at other times closely adjacent, so that it is evident that barriers to migration here and there existed. It could hardly have been otherwise; for local and more widely-spread movements of elevation and depression took place again and again during Palæozoic times.

While the younger Palæozoic systems were being accumulated, excess of upheaval over depression resulted in the gradual increase of the land. The continental plateau came more and more to the surface, in spite of many oscillations of level. It is quite possible, nay, even probable that this persistent growth of land, and consequent modification of oceanic currents, may have rendered the climatic conditions of later Palæozoic times less uniform; but, if so, such diminished uniformity has left no recognisable impress on either faunas or floras. For fossils characteristic of the Devonian and Carboniferous strata of temperate latitudes occur far within the Arctic Circle.

Descending to the Mesozoic era, we find that the character and distribution of marine faunas are still indicative of uniformity. There could have been little difference of temperature at that time between Arctic seas and those of our own latitude. Cosmopolitan species abounded in the Jurassic waters, but were relatively less numerous in those of the Cretaceous period. Professor Neumayr maintains that already, in the Jurassic period, the climate had become differentiated into zones. This, he thinks, is indicated by the fact that coral reefs abound in the Jurassic strata of Central Europe, while they are wanting in the contemporaneous deposits of boreal regions. Dr Heilprin, on the other hand, is of opinion that this and certain other distinctive features of separate Jurassic life-provinces may not have been due to differences of temperature, but rather to varying physical conditions, such as character of the sea-bottom, depth of water, and so forth. Perhaps the safest conclusion we can come to, in the present state of the evidence, is that the climatic conditions of the Mesozoic era were, upon the whole, less obviously uniform than those of earlier ages, but that marked zones of climate like the present had not as yet been evolved. At the same time, when we consider how many great geographical revolutions took place during the period in question, we must be prepared to admit that these could hardly fail to have influenced the climate, and thus to have induced modifications in the distribution of faunas and floras. And probably

evidence of such modifications will yet be recognised, if indeed the phenomena referred to by Neumayr be not a case in point. It may be noted, further, that while, according to many botanists, the plants of the Palæozoic periods bespeak not only uniform climatic conditions but the absence of marked seasonal changes, those of late Mesozoic times are indicative of less uniformity. The Cretaceous conifers, for example, show regular rings of growth, and betoken the existence of seasons, which were much less marked, however, than is now the case.

The geographical changes of Mesozoic times were notable in many respects. The dominant features of Europe, already foreshadowed in early Palæozoic times, had become more clearly outlined before the close of the Cretaceous period. Notwithstanding many movements of depression, the chief land-areas continued to show themselves in the north and north-west. The highest grounds were the Urals, and the uplands of Scandinavia and Britain. In Middle Europe the Pyrenees and the Alps were as yet inconsiderable heights, the loftiest lands in that region being those of the Harz, the Riesengebirge, and other tracts of Archæan and Palæozoic rocks. The lower parts of England and the great lowland plains of Central Europe were sometimes submerged in the waters of a wide, shallow sea, but ever and anon elevation ensued, new lands appeared, and these waters became divided into a series of large inland seas and lakes. In the south, a deep Mediterranean sea would appear to have persisted all through the Mesozoic era—a sea of considerably greater extent, however, than the present.

While in Europe the dominant features of the continental plateau run approximately west and east, in North America they follow nearly the opposite direction. In early Mesozoic times, vast tracts of dry land extended across the northern and eastern sections of the latter area. Over the Rocky Mountain region, low lands and saline lakes appear to have stretched, while further west the area of the Great Plateau and the Pacific slope were covered by the sea. Towards the end of the Mesozoic era, the land in the far west became

more continuous—a broad belt extending in the direction of the Pacific coast-line from Mexico up to high northern latitudes. In short, before the Cretaceous period closed, the major portion of North America had been evolved. A considerable tract of what is now the western margin of the continent, however, was still under water, while from the Gulf of Mexico (then much wider than now) a broad Mediterranean Sea swept north and north-west through Texas and the Rocky Mountain region to communicate with the Arctic Ocean. All to the east of this inland sea was then, as it is now, dry land. Thus, up to the close of the Cretaceous period, in America and Europe alike, oceanic currents coming from the south had ready access across the primeval continental plateau to the higher latitudes. Southern Europe, indeed, during Mesozoic times, was simply a great archipelago, having free communication on the one hand across the low grounds of Central and Northern Russia with the Arctic Seas, and, on the other, across vast regions in Asia with the Indian Ocean.

Of the other great land-masses of the globe our knowledge is too limited to allow us to trace their geographical evolution with any confidence. But, from the very wide distribution of Mesozoic strata in South America, Africa, Asia, and Australia, there can be no doubt that, at the time of their accumulation, enormous tracts in those regions were then under water. The land-masses, in short, were not so continuous and compact as they are at present. And although we must infer that considerable areas of Mesozoic land are now submerged, yet these cannot but bear a very small proportion to the wide regions which have been raised above the sea-level since Mesozoic times. In short, from what we do know of the geological structure of the continents in question, we can hardly doubt that they have passed through geographical revolutions of a like kind with those of Europe and North America. Everywhere over the great continental plateau elevation appears, in the long run, to have been in excess of depression, so that, in spite of many subsidences, the tendency of the land throughout the world has been to extend its margins, and to become more and more con-

solidated. The Mesozoic lands were larger than those of the preceding Palæozoic era, but they were still penetrated in many places by the sea, and warm currents could make their way over wide tracts that are now raised above the sea-level. Under such circumstances, approximately uniform conditions of climate could not but obtain.

Great geographical changes supervened upon the close of the Cretaceous period. North America then acquired nearly its present outline. Its Mediterranean sea had vanished, but the Gulf of Mexico still overflowed a considerably wider region than now, while a narrow margin of the Pacific border of the continent continued submerged. In Europe elevation ensued, and the sea which had overspread so much of the central and eastern portions of our continent disappeared. Southern Europe, however, was still largely under water, while bays and inlets extended northwards into what are now the central regions of the continent. On to the close of the Miocene period, indeed, the southern and south-eastern tracts of Europe were represented by straggling islands. In middle Cainozoic times, the Alps, which had hitherto been of small importance, were considerably upheaved, as were also the Pyrenees and the Carpathians; and a subsequent great elevation of the Alpine area was effected after the Miocene period. Notwithstanding these gigantic movements, the low-lying tracts of what is now Southern Europe continued to be largely submerged, and even the central regions of the Continent were now and again occupied by broad lakes, which sometimes communicated with the sea. After the elevation of the Miocene strata, these inland seas disappeared, but the Mediterranean still overflowed wider areas than it does to-day. Eventually, however, in late Pliocene times, the bed of that sea experienced considerable elevation; and it was probably at or about this stage that the Black Sea and the Sea of Azov retreated from the broad low grounds of Southern Russia, and that the inland seas and lakes of Austria-Hungary finally vanished.

The movements of upheaval, which caused the Cretaceous seas to disappear from such broad areas of the continental plateau, induced many changes in the floras and faunas of

the globe. A notable break in the succession occurs between the Cretaceous and the Eocene, hardly one species of higher grade than the protozoa passing from one system to the other. In the Cainozoic deposits, we are no longer confronted with numerous cosmopolitan species—the range of marine forms has become much more restricted. Nevertheless, the faunas and floras continue to be indicative of much warmer climates for Arctic and temperate latitudes than now obtain. But, at the same time, differentiation of climate into zones is distinctly marked. In the early Cainozoic period, our present temperate latitudes supported a flora of decidedly tropical affinities, while the fauna of the adjacent seas had a similar character. Later on the climate of the same latitudes appears to have passed successively through sub-tropical and temperate stages. In short, a gradual lowering of the temperature is evinced by the character and distribution both of floras and faunas. The differentiation of the climate during one stage of the Cainozoic era is well illustrated by the Miocene flora. Thus, at a time when Italy was clothed with a tropical vegetation, in which palm-trees predominated, Middle Europe had its extensive forests of evergreens and conifers, while in the region of the Baltic, conifers and deciduous trees were the prevalent forms.

When one takes into consideration the fact that, notwithstanding many oscillations of level, the land during Cainozoic times was gradually extending, and the sea disappearing from wide regions which it had formerly covered, one can hardly doubt that the seemingly gradual change from tropical to temperate conditions was due, in large measure, to that persistent continental growth. I confess, however, that it is difficult to account for the very genial climate which continued to prevail over the Arctic regions. So far as one can gather from the evidence at present available, some of the marine approaches to those latitudes had been cut off by the movements of elevation which brought the Cainozoic era to a close, while the Arctic lands were perhaps more extensive than they are now. The Cretaceous Mediterranean of North America had vanished, and we cannot prove that the Tertiary Sea of Southern Europe communicated across the

low grounds of Russia with the Arctic Ocean. We know, however, that the Archipelago of Southern Europe was in direct connection with the Indian Ocean, and it is most probable that a wide arm of the same sea stretched north from the Aralo-Caspian area through Siberia. Indeed, much of what are now the lowlands of western and northern Asia were probably sea in Tertiary times. It seems likely, therefore, that, even at this late period, marine currents continued to reach the Arctic zone, across the continental plateau. When the warm waters of the Indian Ocean eventually ceased to invade Europe, and the Mediterranean became much restricted in area, the climate of the whole continent could not fail to be profoundly affected.

There is yet another line of evidence to which brief reference may be made. I have spoken of the remarkable uniformity of climatic conditions which obtained in Palæozoic times, and the gradual modification of those conditions which subsequently supervened. Now, it is worthy of note that, in their lithological characters, the oldest sedimentary strata themselves likewise exhibit a prevalent uniformity which, in later systems, becomes less and less conspicuous. The Cambro-Silurian mechanical sediments, for example, maintain much the same character all the world over; and the like is true, although in a less degree, of the marine accumulations of the Devonian period. The corresponding mechanical deposits of later Palæozoic ages continue to show more and more diversity, but at the same time they preserve a similarity of character over much more extensive areas than is found to be the case with the analogous sediments of the Mesozoic era. Finally, these last are more or less strongly contrasted with the marine mechanical accumulations of Cainozoic times, which are altogether more local in character. This increasing differentiation is quite in keeping with what we know of the evolution of our land-areas. In early Palæozoic ages, when insular conditions prevailed and the major portion of the primeval continental plateau was covered by shallow seas, it is obvious that mechanical sediments would be swept by tidal and other currents over enormous areas, and that these sediments

would necessarily assume a more or less uniform character. Indeed, I suspect that much of the sediment of these early seas may have been the result of tidal scour, and that marine erosion was more generally effective than it is now. With the gradual growth of the land and the consequent deflection and limitation of current-action marine mechanical sediments would tend to become more and more local in character. Thus the increasing differentiation which we observe in passing from the earlier to the later geological systems is just what might have been expected.

Summing up now, the results of this rapid review of the evidence we seem justified in coming to the following conclusions—

1. In Pretertiary times Europe and North America were represented by considerable areas of dry land, marked chiefly by high mountains, while further south groups of smaller islands were scattered over the submerged surface of the tropical and subtropical regions. The other continents appear to have consisted of low-lying tracts, or islands—some of which may have been connected with the main masses. A very considerable amount of volcanic activity accompanied these periods.

2. In the Pretertiary period the climate was generally warm, and the sea-level was high, so that the land areas were limited to narrow strips along the coasts and to the high mountains. The sea was shallow, and the water was warm, and the climate was generally warm.

3. The Pretertiary period was marked by a general increase in the amount of land, and a corresponding decrease in the area of the sea. The land was generally low-lying, and the sea was shallow, and the climate was generally warm.

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Vice-President's Address.

conditions of the Quaternary period. These, however, now so well known, that I need do no more than remark that, so far as the chief features of our lands are concerned, all these had come into existence before the dawn of the Age. The greater contours of the surface, which were shadowed in Palæozoic times, and which in Mesozoic were more clearly indicated, had been fully evolved close of the Pliocene period. The connection between the Mediterranean and the Indian Ocean probably ceased Pliocene times. The most remarkable geographical changes which have taken place since then within European have been successive elevations and depressions, in consequence of which the area of our continent has been altered and diminished. At a time well within the Pleistocene period, our own islands have been united to the continent, and the dry land has extended north, so as to include Spitzbergen, the Færoe Islands, perhaps Iceland. On the other hand, our islands have within a recent period largely submerged. North America, we are furnished with many oscillations of level having taken place in Quaternary times. Is it possible, then, to explain the climatic vicissitudes of the Pleistocene period by means of such oscillations? geologists have tried to do so, but all these attempts have failed. It is quite true that a general elevation in high latitudes would greatly increase the ice-bearing regions, and might even give rise to permanent glaciers in the mountain-districts of our islands. It is inconceivable that any such geographical change could be brought about that general lowering of the ice-bearing whole northern hemisphere which took place in Pleistocene times. For we have to account for the extensive glaciation of northern and north-western Europe, and the northern parts of North America, but for the ice-free snow-fields and glaciers in much more southern latitudes, and in many parts of Asia where no permanent ice exists. Moreover, we have to account for the various oscillations of climate obtained in the Quaternary period, when the land was relatively much more extensive than at present.

The Arctic shell-beds of our own and other temperate regions sufficiently prove that geographical conditions were not the only factor concerned in bringing about the peculiar climate of the Pleistocene period. Then, again, we must not forget that at certain stages of the same period genial conditions of climate were coincident with a much wider land-surface in north-western Europe than now exists. The very fact that interglacial deposits occur in every glaciated region is enough of itself to show that the Arctic conditions of the Pleistocene could not have resulted entirely from a mere elevation of land in the northern parts of our hemisphere.

The only explanation of the peculiar climatic vicissitudes in question which seems to meet the facts, so far as these have been ascertained, is the well-known theory advanced by Dr Croll. After carefully considering all the objections which have been urged against that theory, there is only one, as it seems to me, that is deserving of serious attention. This objection is not based on any facts connected with the Pleistocene deposits themselves, but on evidence of quite another kind. It is admitted that, were the Pleistocene deposits alone considered, Croll's theory would fully account for the phenomena. But, it is argued, we cannot take the Pleistocene by itself, for if that theory be true, then climatic conditions similar to those of the Pleistocene must have supervened again and again during the past. Where, then, we are asked, is there any evidence in Palæozoic, Mesozoic, or Cainozoic strata of former wide-spread glacial conditions? If continental ice-sheets, comparable to those of the Pleistocene, ever existed in the earlier ages, surely we ought to find more or less unmistakable traces of them. Now, at first sight, this looks a very plausible objection, but it has always seemed to me to be based upon an assumption that is not warranted by our knowledge of geographical evolution. Dr Croll would be the first to admit that high eccentricity of the earth's orbit might have happened again and again without inducing glacial conditions like those of the Pleistocene. The objection takes no account of the fact that the excessive climate of the glacial period was only possible because of special geographical conditions—conditions that do not appear to have been fully

evolved before Pliocene times. No one has seen this more clearly than Mr Wallace,¹ with the general drift of whose argument I am quite at one. In earlier ages, the warm water of the tropics overflowed wide areas of our present continents—most of the dry land was more or less insular, and the seas within the Arctic Circle were certainly not cold as at present, but temperate and even genial. If we go back to Cambro-Silurian times, we find only the nuclei, as it were, of our existing continents appearing above the surface of widespread shallow seas. It is quite impossible, therefore, that under such geographical conditions, great continuous ice-sheets, like those of the Pleistocene, could have existed—no matter how high the eccentricity of the earth's orbit may have been. The most that could have happened during such a period of eccentricity, would be the accumulation of snow-fields on mountains and plateaux of sufficient height, the formation here and there of local glaciers, and the descent of these in some places to the sea. And what evidence of such local glaciation might we now expect to find? No old land surface of that far-distant period has come down to us: we look in vain for Cambro-Silurian *roches moutonnées* and boulder-clay or moraines. The only evidence we could expect is just that which actually occurs, namely, erratics (some of them measuring five feet and more in diameter) embedded in marine deposits. It may be said that a few erratics are hardly sufficient to prove that a true glacial period supervened in Cambro-Silurian times, and I do not insist that they are. But I certainly maintain that if any lowering of the temperature were induced by high eccentricity of the earth's orbit during Cambro-Silurian times, then ice-floated erratics are the only evidence of refrigeration that we need ever hope to find. The geographical conditions of early Palæozoic times forbade the formation of enormous ice-sheets like those of the Pleistocene period. Extreme climatic changes were then impossible, and periods of high eccentricity might have come and gone without inducing any modifications of flora and fauna which we could now recognise. We are practically ignorant of the terrestrial life of the globe at that distant

¹ See *Island Life*.

period, and our knowledge of the marine fauna is not sufficient to enable us to deny the possibility of moderate fluctuations in the temperature of the seas of early Palæozoic times. Moreover, we must not forget that there were then no such barriers to migration as now exist. If the conditions became temporarily unsuitable, marine organisms were free to migrate into more genial waters and to return to their former habitats when the unfavourable conditions had passed away.

The uniform climate so characteristic of the Cambro-Silurian period appears to have prevailed likewise during the later stages of the Palæozoic era. This we gather from a general consideration of the floras and faunas and their geographical distribution. The dry land, as we have seen, continued to increase in extent; but vast areas of the primeval continental plateau of the globe still continued under water, and currents from southern latitudes flowed unrestricted into Polar regions. During the protracted lapse of time required for the formation of the later Palæozoic systems, several periods of high eccentricity must have occurred. But, so far as one can judge, the disposition of the larger land-areas was never such as to induce a true Ice Age. Nevertheless, we are not without evidence of ice-action in Old Red Sandstone, Carboniferous, and Permian strata. And it seems to me probable that the erratic accumulations referred to may really indicate local glacial action, of more or less intensity, brought about by such lowering of the temperature as would supervene during a period of high eccentricity. It is true we may explain the phenomena by inferring the existence of mountains of sufficient elevation—and this, indeed, is the usual explanation. But it is doubtful whether those who adopt that view have fully considered what it involves. Take, for example, the case of the breccias and conglomerates of the Lammermuir Hills, which have all the appearance of being glacial and fluvio-glacial detritus. These deposits overlie the highly denuded Silurian greywackés of Haddingtonshire in the north and of Berwickshire in the south, and have evidently been derived from the intervening high grounds—the width of which between the Old Red Sandstone accumulations in

question does not exceed eight or nine miles. The breccias reach a height of 1300 feet, while the dominating point of the intervening uplands is 1700 feet. Under present geographical conditions it is doubtful whether perennial snow and glaciers of any size at all could exist in the region of the Lammermuirs at a less altitude than 7000 feet or more. But between the breccias of Haddingtonshire and the equivalent deposits in Berwickshire there is no space for any intermediate range of mountains of circumdenudation of such a height. Moreover, we must remember that under the extremely uniform conditions which obtained in Palæozoic times the snow-line could not possibly have been attained even at that elevation. When the Devonian coral-reefs described by Dupont were growing in the sea that overflowed Western Europe, to what height must the southern uplands of Scotland have been elevated in order to reach the snow-line! We may make what allowance we choose for the denudation which the Silurian rocks of the Lammermuirs must have experienced since the deposition of the Old Red Sandstone, but it is simply a physical impossibility that mountains of circumdenudation of the desiderated height could ever have existed in the Lammermuir region at the time the coarse breccias were being accumulated.¹ It seems to me, then, that these breccias are in every way better accounted for by a lowering of temperature due to increased eccentricity of the orbit. This view frees us from the necessity of postulating excessive upheavals over very restricted areas, and of creating Alps where no Alps could have existed.

When we consider the enormous thickness of the strata that constitute any of our larger coal-fields, we can hardly doubt that one or more periods of high eccentricity must have occurred during their accumulation. It does not follow, however, that we should be able to detect in these

¹ It may be objected that the conglomerates were probably not marine, but deposited in lakes, the beds of which may have been much above sea-level. But from all that we know of the Old Red Sandstone of Scotland, it would appear that the lakes of the period now and again communicated with the sea, and were probably never much above its level.

strata any evidence of alternating cold and warm epochs. So long as ocean-currents from the tropics found ready entrance to polar regions across vast tracts of what is now dry land, extreme and wide-spread glacial conditions were impossible. Any lowering of temperature due to cosmical causes might indeed induce new snow-fields and glaciers to appear or existing ones to extend themselves in northern regions and the most elevated lands of lower latitudes. But such local glaciation need not have seriously affected any of the areas in which coal-seams were being formed. For nothing appears more certain than this, that our coal-seams as a rule were formed over broad, low-lying, alluvial lands, and in swamps and marshes, along the margins of estuaries or shallow bays of the sea. Some seams, it is true, are evidently formed of drifted vegetable débris, but the majority point to growth *in situ*. The strata with which they are associated are shallow-water sediments which could only have been deposited at some considerable distance from any mountain-regions in which glaciers were likely to exist. It is idle, therefore, to ask for evidence of glacial action amongst strata formed under such conditions. The only evidence of ice-work we are likely to get is that of erratics. And these are not wanting, although it is probable that most of those which are found embedded in coals have been transported by rafts of vegetable matter or in the roots of trees. The same explanation, however, will not account for the boulders which Sir William Dawson has recorded from the coal-fields of Nova Scotia. He describes them as occurring on the outside of a gigantic esker of Carboniferous age, and thinks they were probably dropped there by floating ice at a time when coal-plants were flourishing in the swamps on the other side of the gravel embankment.

If the disposition of the land-areas in Carboniferous times rendered such an ice age as that of the Pleistocene impossible—in other words, if the effects flowing from high eccentricity of the orbit must to a large extent have been neutralised—the flora and fauna of the period can hardly be expected to yield any recognisable evidence of fluctuating

climatic conditions. When our winter happened in aphelion new snow-fields might have appeared, or already existing glaciers might have increased in size; while, with the winter in perihelion, the temperature of northern latitudes would doubtless be raised. But the general result would simply be an alternation of warm and somewhat cooler conditions. And such fluctuations of climate might readily have taken place without materially modifying the life of the period.

The breccias of the Permian system have been described by Ramsay as of glacial origin. Some geologists agree with him, while others do not—and many have been the ingenious suggestions which these last have advanced in explanation of the phenomena. Some have tried to show how the stones and blocks in the breccias may have been striated without having recourse to the agency of glacier ice, but they cannot explain away the fact that many of the stones (which vary in size from a few inches to three or four feet in diameter) have travelled distances of thirty or forty miles from the parent rocks. Similar erratic accumulations, which may belong to the same system or to the Carboniferous, occur in India and Australia. According to Dr Blanford, the Indian boulder-beds are clearly indicative of ice-action, and he does not think that they can be explained by an assumed former elevation of the Himalaya. On the contrary he is of opinion that the facts are best accounted for by a general lowering of the temperature, due probably to the action of cosmical causes. Daintree, Wilkinson, R. Oldham, and others who have studied the Australian erratic beds, have likewise stated their belief that these are of true glacial origin.

I may pass rapidly over the Mesozoic systems, taking note, however, of the fact that in them we encounter evidence of ice-action of much the same kind as that met with in Palæozoic strata. While, on the one hand, the Mesozoic floras and faunas bespeak climatic conditions similar to those of earlier ages, but probably not quite so uniform; on the other, the occurrence of erratics in various marine accumulations is sufficient to show that now and again ice floated across seas, the floors of which were tenanted by reef-building corals. The geographical con-

ditions continued unfavourable to the formation of extensive ice-sheets in temperate latitudes, no matter how high the eccentricity of the orbit might have been. The erratics which occur in certain Jurassic and Cretaceous deposits are admitted by most geologists to have been ice-borne. Now, it is highly improbable that the transporting agent could have been coast-ice, for it is hardly possible to conceive of ice forming on the surface of a sea in which flourished an abundant Mesozoic fauna. The erratics, therefore, seem to imply the existence in Mesozoic times of local glaciers, which here and there descended to the sea, as in the north-east of Scotland. The erratics in the Scottish Jurassic are evidently of native origin, and it is most improbable that those which have been met with in the chalk of England and France could have floated from any very great distance. How, then, can we explain the appearance of local glaciers in these latitudes during Mesozoic times? The geographical conditions of the period could not have favoured the formation of perennial snow and ice in our area, unless our lands were at that time much more elevated than now. And this is the usual explanation. It is supposed that mountains much higher than any we now possess probably existed in such regions as the Scottish Highlands. It is easy to imagine the former existence of such mountains. So long a time has elapsed since the Jurassic period, that the Archæan and Palæozoic areas cannot but have suffered prodigious denudation in the interval. But, when one considers how very lofty, indeed, those mountains must have been, in order to reach the snow-line of Jurassic times, one may be excused for expressing a doubt as to whether the suggested explanation is reasonable. At all events, the phenomena are, to say the least, as readily explicable on the supposition that the snow-line was temporarily lowered by cosmical causes. Even with eccentricity at a high value, no great ice-sheets, indeed, could have existed, but local snow-fields and glaciers might have appeared in such mountain-regions as were of sufficient height. And this might have happened without producing any great difference in the temperature of the sea, or any marked modification in the distribution of life. In

short, we should simply have, as before, an alternation of warm and somewhat cooler climates, but nothing approaching to the glacial and interglacial epochs of the Pleistocene.

These conclusions seem to me to be strongly supported by the evidence of ice-action during Tertiary times. The gigantic erratics of the Alpine Eocene do not appear to have been derived from the Alps, but rather from the Archæan area of Southern Bohemia. The strata in which they occur are, for the most part, unfossiliferous; they contain only fucoidal remains, and are presumably marine. How is it possible to account for the appearance of these erratics in marine deposits in central Europe at a time when, as evidenced by the Eocene flora and fauna, the climate was warm? Are we to infer the former existence of an extremely lofty range of Bohemian Alps which has since vanished? Is it not more probable that here, too, we have evidence of a lowering of the snow-line, induced by cosmical causes, which brought about the appearance of snow-fields and glaciers in a mountain-tract of much less elevation than would have been required in the absence of high eccentricity of the orbit? If it be objected that such cosmical causes must have had some effect upon the distribution of life, I reply that very probably they had, although not to any extreme extent. The researches of Mr Starkie Gardner have shown that the flora of the English Eocene affords distinct evidence of climatic changes. But as the geographical conditions of that period precluded the possibility of extensive glaciation, and could only, at the most, have induced local glaciers to appear in elevated mountain-regions, it seems idle to cite the non-occurrence of erratics and morainic accumulations in the Eocene of England and France as an argument against the application of Croll's theory to the case of the erratics of the Flysch. I repeat, then, that under the geographical conditions of the Eocene, all the more obvious effects likely to have resulted from the passage of a period of high eccentricity would be the appearance of a few local glaciers, the existence of which could have had no more influence on the climate of adjacent lowlands than is notable in similar circumstances in our

own day. It is absurd, therefore, to expect to find evidence in Eocene strata of as strongly contrasted climates as those of the glacial and interglacial deposits of the Pleistocene. There must, doubtless, have been alternations of climate in our hemisphere; but these would consist simply of passages from warm to somewhat cooler conditions—just such changes, in fact, as are suggested by the plants of the English Eocene.

The evidence of ice-action in the Miocene strata is even more striking than that of which I have just been speaking. The often-cited case of the erratics of the Superga near Turin, I need do little more than mention. These erratics were undoubtedly carried by icebergs, calved from Alpine glaciers at a time when northern Italy was largely submerged. The erratic deposits are unfossiliferous, and are underlaid and overlaid by fossiliferous strata, in none of which are any erratics to be found. What is the meaning of these intercalated glacial accumulations? Can we believe it possible that the Miocene glaciers were enabled to reach the sea in consequence of a sudden movement of elevation which must have been confined to the Alps themselves? Then, if this be so, we must go a step further, and suppose that, after some little time, the Alps were again suddenly depressed, so that the glaciers at once ceased to reach the sea-coast. For, as Dr Croll has remarked, "had the lowering of the Alps been effected by the slow process of denudation, it must have taken a long course of ages to have lowered them to the extent of bringing the glacial state to a close." And we should, in such a case, find a succession of beds indicating a more or less protracted continuance of glacial conditions, and not one set of erratic accumulations intercalated amongst strata, the organic remains in which are clearly suggestive of a warm climate. The occurrence of erratics in the Miocene of Italy is all the more interesting from the fact that in the Miocene of France and Spain similar evidence of ice-action is forthcoming.

Opponents of Dr Croll's theory have made much of Baron Nordenskiöld's statement, that he could find no trace of former glacial action in any of the fossiliferous formations within the Arctic regions. He is convinced that "an

examination of the geognostic condition, and an investigation of the fossil flora and fauna of the Polar lands, show no signs of a glacial era having existed in those parts before the termination of the Miocene period." Well, as we have seen, there is no reason to believe that the geographical conditions in our hemisphere, at any time previous to the close of the Pliocene period, could ever have induced glacial conditions comparable to those of the Pleistocene Ice Age. The strata referred to by Nordenskiöld are, for the most part, of marine origin, and their faunas are sufficient to show us that the Arctic seas were formerly temperate and genial. If any ice existed then, it could only have been in the form of glaciers on elevated lands. And it is quite possible that these, during periods of high eccentricity, may have descended to the sea and calved their icebergs; and, if so, erratics may yet be found embedded here and there in the Arctic fossiliferous formations, although Nordenskiöld failed to see them. One might sail all round the Palæozoic coast-sections of Scotland without being able to observe erratics in the strata, and yet, as we know, these have been encountered in the interior of the country. The wholesale scattering of erratics at any time previous to the Pleistocene, must have been exceptional even in Arctic regions, and consequently one is not surprised that they do not everywhere stare the observer in the face.

The general conclusion, then, to which I think we may reasonably come, is simply this:—That geological climate has been determined chiefly by geographical conditions. So long as the lands of the globe were discontinuous and of relatively small extent, warm ocean currents reaching Polar regions, produced a general uniformity of temperature—the climate of the terrestrial areas being more or less markedly insular in character. Under those conditions, the sea would nowhere be frozen. But when the land-masses became more and more consolidated, when, owing to the growth of the continents, warm ocean currents found less ready access to Arctic regions, then the temperature of those regions was gradually lowered until eventually the sea became frost-bound, and the lands were covered

with snow and ice. But while the chief determining cause of climate has been the relative distribution of land and water, it is impossible to doubt that during periods of high eccentricity of the orbit, the climate must have been modified in a greater or less degree. In our own day the geographical conditions are such that, were eccentricity to attain a high value, the climate of the Pleistocene would be reproduced, and our hemisphere would experience a succession of alternating cold and genial epochs.

But in earlier stages of the world's history, the geographical conditions were not of a kind to favour the accumulation of vast ice-fields. During a period of extreme eccentricity, there would probably be fluctuations of temperature in high latitudes; but nothing like the glacial and interglacial epochs of the Pleistocene could have occurred. At most, there would be a general lowering of the temperature, sufficient to render the climate of Arctic seas and lands somewhat cooler, and probably to induce the appearance in suitable places of local glaciers; and, owing to precession of the equinox, these cooler conditions would be followed by a general elevation of the temperature above the normal for the geographical conditions of the period. In Paleozoic and Mesozoic times, the effects of high eccentricity of the orbit appear to have been, in a great measure, neutralised by the geographical conditions, with a possible exception in the Permian period. But in Tertiary times when the land-masses had become more continuous, the orbital causes of change referred to must have had greater influence. And I cannot help agreeing with Dr. Deil that the warm climates of the Arctic regions during that era were, to some extent, the result of high eccentricity.

In concluding this discussion, I readily admit that our knowledge of geographical variation is as yet in its infancy. We have still very much to learn, and I shall be the last to estimate upon the subject. But I hope I have made it clear that the evidence, so far as it goes, does not support the particular assertion of Dr. Deil's argument, that, as there is no evidence to what we know of the

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tracts which are now submerged have formerly been dry land—some of these changes having taken place in very recent geological times. And the same conclusions are frequently suggested by geological evidence. Thus there can be little doubt that Europe in Tertiary times extended further into the Northern Ocean than it does now. And it is quite possible that in the Mesozoic and Palæozoic eras considerable land-areas may likewise have appeared here and there in those northern regions which are at present under water. There is hardly any portion, indeed, of the continental plateau which is now submerged that may not have been land at some time or other. But after making all allowance for such possibilities, the geological evidence, so far as it goes, nevertheless leads to the conclusion that upon the whole a wider expanse of the primeval continental plateau has come to the surface since Tertiary times than was ever exposed during any former period of the world's history.

XX. *Notes on Crested Birds of Prey.* By J. G. GOODCHILD,
Esq., F.Z.S., M.B.O.U. [Plate X.]

(Read 18th December 1889.)

In determining what style of plumage would best suit the particular requirements of Birds of Prey, Nature would appear to have taken into consideration what would wear best, and would at the same time make the smallest demands upon the vital energies of the wearers, rather than what would form the most striking kind of adornment. It is more than doubtful whether the majority of these birds would gain any very direct advantage by either assimilative or protective coloration; and even sexual selection, which has played so important a part in the development of adornment amongst other birds, appears hardly to have affected many of the Birds of Prey at all. Everything else seems to have been subordinated to the particular requirements connected with their several predatory modes of life. The colours throughout the entire group are sober combinations of white with various browns, greys, and buffs, which are disposed in simple patterns, consisting of various combinations of stripes, bars, and spots.

Almost the only feature about these birds that has any claim to be regarded as decorative consists in the elongation of one or the other of the various groups of feathers whose bases are situated on the head or the parts adjoining. Several types of such elongated feathers exist; and in the

remarks that follow, it will therefore be as well to distinguish these types by employing terms for them which shall refer to the place of insertion of the feathers in question. In every case the remarks that follow refer to the characteristics presented by living birds, and not by cabinet specimens, as observations upon stuffed examples are simply worthless in the present connection.

Nearly all Birds of Prey are able to raise the feathers on the occiput, and on the nape, more or less; in some even of those that have no claim to be regarded as crested, in the ordinary sense, both the *occipital* and the *nuchal* feathers can be raised into more or less of a crown or frill. In many others, also, the *ear coverts*, the *post-auricular fringes*, and the *mandibular tufts* are capable of being raised so as to stand out from the head more or less. But in certain other forms development has gone much farther. In one of the principal sections of the Owls (Pl. X., Fig. 1) there is the pair of *superciliary tufts* or "horns," a style of ornament almost entirely confined to this particular group, and constituting, in fact, almost the sole feature of the kind under notice that these birds possess. In most of the Diurnal Birds of Prey a slight indication of the same feature may be observed in a few forms. Even in the Falcons the superciliary feathers may occasionally be seen to be raised, as a kind of beading, above the general level of the other feathers of the crown. I have before me as I write several drawings of a living example of *Falco sacer* that show this feature in rather a marked manner; and I have repeatedly noticed it more or less in making drawings from life of other falcons. But in no case do these superciliary feathers ever become elongated to very striking proportions in any of the Diurnal Birds of Prey.

In the CIRCINÆ, the post-auricular feathers are elongated more than in most others, and these when raised, form a well-marked frill below and behind the eyes. In the Harpy (*Thrasaëtus harpyia*) (Pl. X., Fig. 2a), and in the Crowned Hawk Eagle (*Spizaëtus coronatus*) (Pl. X., Fig. 3a), the elongation of these post-auricular tufts is carried to a much greater extent; and the birds are able, under certain emotions,

to spread out broad, fan-shaped groups of these feathers on either side of the head, which, as the figures show, impart very striking characteristics to their physiognomy under these circumstances. The feature, in less striking proportions, is observable in a few other species.

The Harpy affords also a good illustration of another type. In this the feathers originating on what (for want of a better name) may be termed the parietal region of the skull, are elongated in such a manner as to form a pair of postero-lateral or *parietal* tufts (Pl. X., Figs. 2-6). These are capable of erection at will, and they present, when half-raised, the form of lateral crests—the edges of the feathers on the crown of the head forming a hollow between them. But the bird can spread out each tuft as well as raise it, and is able, moreover, to completely invert these feathers in such a manner that their free ends are directed forward over the facial region (Pl. X., Fig. 4). As the post-auricular tufts are usually raised also at such times, the Harpy then presents as striking a figure as can be found throughout the whole of the Sub-Class Aves. *Spizaëtus coronatus* resembles *Thrasaëtus* also in this feature, and differs accordingly from all the normal *Spizaëti*.

In *Dicholophus*, the Çariamás (whose taxonomic position is somewhere on the borders of the group under notice), there is a well-developed median *frontal tuft* (Pl. X., Fig. 5), but as the exact relationship of these birds to the Birds of Prey has not yet been satisfactorily determined, I now pass it by without further mention. At any rate, there is no such crest amongst the acknowledged Birds of Prey.

The remaining style of crest to be noticed is that already well known under the name of *occipital crest*, from the region of the skull where it originates. In nearly all cases this crest is median in position, although the extent to which it is developed laterally is subject to considerable variation. There are several forms of occipital crest. One of these is that of the heavy, wide, plume of rounded feathers displayed upon the head of nearly all the genera of the HERPETOTHERINÆ. *Helotarsus*, the Bateleur Eagle (Pl. X., Fig. 6), *Spilornis* (Pl. X., Fig. 6a), and *Polyborides* (Pl. X., Fig. 6b),

afford good examples. Another type is that of the loose bunch of spatulate feathers (Pl. X., Fig. 7) that decorate *Serpentarius*, the Secretary Bird. This form of crest can be spread out radially from the place of insertion, so as to form a wide crown (Pl. X., Fig. 7a). A third development is that of the loose tuft of elongated feathers that decorates *Lophoaëtus*, the Black Crested Eagle of South Africa (Pl. X., Fig. 8). In many individuals of this species the tuft in question is habitually inverted, and consequently droops forward so that the tips of the longest feathers nearly touch the crown of the head. A fourth type of occipital crest is represented by the neat, smart, pointed tuft seen in *Baza*, the normal *Spizaëti* (Pl. X., Fig. 9), *Harpyhaliaëtus* (Pl. X., Fig. 10), and some others.

Each of these styles of ornament may pass into, or may be combined with, any of the others; so that *living* specimens of the crested Birds of Prey present a wider range of variety in this respect than do the others.

So far the facts. Can we discover any reasons for them? The features in question appear to me not to be due to sexual selection, because the decorations are not confined to the males, but are, in general, common to both sexes. That the crested condition is not an independent development in each species, connected with its own special need, is, I think, evident from the fact that the immature forms of many species are often as much crested as the adults; and indeed, in some species, appear to be even more so. This fact is the more striking, because many of these crested forms of Birds of Prey (unlike the majority of the remainder) pass through several changes of plumage before they attain to the mature form. *Spizaëtus ornatus*, for example, passes through at least four successive changes of plumage before it becomes adult, and yet it is crested through them all.

It appears to me, therefore, that we are fully justified in regarding the possession of a crest as a character older than the species. But all the species of certain genera (*Spizaëtus*, for example) are crested in one way or another. It is extremely unlikely that all the species of a genus, widely dispersed over the face of the earth, living under a great

variety of surroundings, and differing from each other more or less in their habits, should have each evolved crests independently. We may, therefore, conclude that the possession of this character dates back at least as far as the differentiation that gave rise to the genus. But several allied genera, united into one sub-family by certain common points of structure, agree also in this particular feature, and are crested on the same type. For example, taking the HERPETOTHERINÆ, we find that all the genera, *Spilornis*, *Eutriorchis*, *Helotarsus*, etc., agree in possessing a great development of broad, round-ended, occipital feathers; although the several genera composing that sub-family are distributed over the greater part of Huxley's Notogæa. Then again, to take another example, all four genera ranged under the THRASAËTINÆ are crested in one way or another. Even in the AQUILINÆ seven out of the nine sub-genera ranged under this sub-family are crested, and of one of the remaining genera, *Aquila* itself, a single species, *A. desmursii*, possesses a distinct occipital crest.

These facts appear to me quite to warrant us in regarding the feature under notice as one of great antiquity, and as having been transmitted, with but little modification, from the parent stock of each of the sub-families whose members now possess such decorations. Where did those crested ancestors originate? If we study the geographical distribution of the existing crested genera, it seems to me that we can obtain some kind of reply. We will take the various groups *seriatim*, noting whether they contain crested forms or not; and, if they do, in what zoological provinces these particular forms occur:—FALCONINÆ, no crested forms. ACCIPITRINÆ—*Lophospizias*, alone: Indian Region. BUTEONINÆ, none. MILVINÆ—*Baza*, alone: Oriental Region and N. Australia, S.-W. Africa. CIRCINÆ, none. PERNIDÆ¹—*Machæramphus*: S.-W. Africa, Madagascar, and Malacca. *Pernis* (one species of): Indian Region. GYMNOGENINÆ—*Polyboroides*: Ethiopian Region and Madagascar. HERPETOTHERINÆ—*Herpetotheres*:

¹ The Honey Buzzards and their allies appear to me to be aberrant forms, and quite entitled to be regarded as the existing representatives of a nearly extinct family.

Neotropical. *Spilornis*: Oriental. *Dryotriorchis*: Ethiopian. *Eutriorchis*: Madagascar. *Helotarsus*: Ethiopian. THRASAËTINÆ—*Thrasaëtus*, *Morphnus*, *Harpyopsis*, and ? *Harpyhaliaëtus* (Pl. X., Fig. 10): all Neotropical. AQUILINÆ—*Spizaëtus*: Neotropical, Ethiopian, and Oriental; one species ranges to Japan. *Lophotriorchis*: Neotropical, Oriental. *Spiziastur*: Neotropical? *Neopus*: Oriental. Of the HALIAËTINÆ, VULTURIDÆ, GYPOHIERACINÆ, GYPAËTIDÆ, the PAN-DIONES, and the CATHARTI, not a single form is crested; while the remaining section, the SERPENTARII, is represented by the well-crested Secretary Bird of Southern and Eastern Africa.

An examination of these curious facts of distribution leads us at once to the generalization that, if we except the *Baza* that has crossed Wallace's Line into Australia, and the *Spizaëtus* that, similarly, has wandered into Japan, not a single crested diurnal Bird of Prey ranges into the Nearctic, the Palæarctic, or the Australian Regions. If the fact stood alone, we might be disposed to regard it as a singular coincidence, and nothing more. But when it is considered in conjunction with other facts of the same nature, brought into more or less prominence of late years, it is seen to form an additional link in a long chain of evidence which scientific zoology has brought to bear upon the history of the former changes of the earth's surface. We now know that families, sub-families, and even genera, of organised beings are in many cases older than many of the larger features of the countries they inhabit. Some appear to be older even than the continents. We are, therefore, it seems to me, justified in supposing that the region where crests were first developed amongst the ancestral forms of the five sub-families that now bear them was an area now submerged, but which, under the different geographical conditions of former periods of the earth's history, was connected on its western margin with what is now the eastern limit of the Neotropical Region. The area may have existed somewhere between where Cape Horn and the Cape of Good Hope are now. As the physical geography of that old continent (or archipelago) changed, land surfaces were propagated in the direction of the present Neotropical

Region on the one hand, and on the other in that of the old Lemuria of Dr Sclater (an hypothetical region, in whose former existence many competent geologists and biologists still believe). From the Lemurian continent or archipelago, in still later times, the crested forms spread to what is now the Oriental Region; and, later still—when the present limits of the Ethiopian Region began to be marked out, and Lemuria to be submerged—other forms were extended into Madagascar and Southern Africa.

How and why the ancestral forms became crested, or retained crests, may long remain a subject for speculation. But I think we may safely conclude that the crests themselves are, as a feature, older not only than the genera or the sub-families that bear them, but older even than the continents—perhaps (as I believe they are) older than some of the oceans.

XXI. *Zoological Notes.* By FRANK E. BEDDARD, Esq., M.A., F.R.S.E., F.Z.S., Prosector to the Zoological Society of London, Lecturer on Biology at Guy's Hospital.

II.

AQUATIC EARTHWORMS.

(Read 18th December 1889.)

It is well known that many of the Oligochæta, which are usually found in ponds and rivers, can also live in damp soil. The Enchytræidæ, for example, appear to contain quite as many terrestrial as aquatic forms; and even the same species may occur in either habitat. But there are not many instances known of earthworms which lead a partially or entirely aquatic life; indeed the fact that these Annelids have been generally supposed to be entirely terrestrial, has been to some extent the cause of their having been distinguished as a separate group of the Oligochæta—*Oligochæta Terricolæ*. So far as I am aware, there is only one species closely allied to *Lumbricus terrestris*, which has been proved to occur in rivers, as well as in the soil. In a recent number

of *Nature*, Mr Benham noted the occurrence of *Allurus tetraedrus* in England, and stated that his specimens had been collected in a stream. During August of last year, I discovered this worm to be very abundant in the river at Bickleigh near Plymouth. The river was not at all flooded, and as the worms were tolerably abundant, it seems to me to be fairly certain that they were not accidentally present. Professor Vejdovsky has also recorded the fact that *Allurus* is found in streams in Bohemia; so there can be but little doubt that it is partially aquatic in its habit; it can certainly live equally well in the soil, as I have had the opportunity of examining some examples which Mr E. B. Poulton was good enough to collect for me in the island of Teneriffe. I have lately received a collection of *Oligochæta* from the Falkland Islands through the kindness of Mr Dale; I had particularly asked that gentleman to collect aquatic as well as terrestrial *Oligochæta*; I received two fresh-water species belonging to the genus *Acanthodrilus*, which has been hitherto supposed to be a purely terrestrial form. One of these species proves to be *A. georgianus* (Michaelsen), recently described, from South Georgia; the other is a new species. There is no doubt, from what Dr Dale tells me, that these species are really aquatic.

I am not aware that any exact observations have been made as to the length of time which various species of earthworms can survive when placed in water; it is clear, however, that many species can live for a long time—several months, according to Perrier—in fresh water. On the other hand it is quite a usual sight, after rain, to see numerous worms lying dead in the rain puddles; Darwin has suggested that these are individuals in a dead or dying condition, which have been washed out of their burrows. Mr W. W. Smith, in an interesting paper upon the habits of New Zealand earthworms (*Trans. N. Z. Instit.*, vol. xix., p. 129), holds that these individuals are really drowned, in some cases at least. It seems to me probable that in many cases the dead worms lying in the rain puddles have been killed by the sun's rays heating the water. Although there is no doubt that earthworms can live in water, I am not aware of

any species, except those recorded in this note, which have been found living in streams and ponds, unless unusual floods have washed them into such situations. It is therefore important to notice that there are three species which are largely aquatic in their habits, or four, if *Criodrilus* be admitted.

It may be, perhaps, a mere coincidence that in two at any rate out of the four aquatic forms mentioned in the present note, there is a certain approximation in structure to limicoline genera, although this approximation is not in the direction of any special adaptation to an aquatic life—at any rate not as far as we can see at present.

The progress of recent investigation into the structure of Oligochæta has broken down all the distinction between the “Terricolæ” and “Limicolæ” except one, which has been, on the contrary, confirmed. That distinction is seen in the ova. In the Naidomorpha, Enchytræidæ, Lumbriculidæ, Tubificidæ, etc., the ova are few and large, the large size being due to the increased quantity of yolk stored up in the ovum; in earthworms, on the contrary, the ova are minute with a very small quantity of yolk. To a certain degree *Allurus* and *Acanthodrilus Dalei*¹ are intermediate in character; the ova are much larger than those of earthworms in general, but are much smaller than the ova—heavily laden with yolk—of such forms as *Tubifex*. Without attempting—for the present—to decide whether the large yolk ovum is or is not the original condition in the Oligochæta, it is clear that as both kinds of ova occur in allied forms, one must have been derived from the other during the evolution of the group; and it is therefore permissible to regard the large ova of *Allurus* and especially of *Acanthodrilus* as intermediate in character.

¹ Named after Dr Dale of the Falkland Islands Company.

XXII. *On the Structure of Coccosteus decipiens, Agassiz.*

By Dr R. H. TRAQUAIR, F.R.S., F.G.S. [Plate XI.]

(Read 18th December 1889.)

In a paper (13) on *Homosteus* published in the *Proceedings* of this Society for Session 1888-89, I entered into the structure of *Coccosteus* so far as was necessary for the purpose of instituting a comparison between the two genera. In the present communication I propose to consider the structure of *Coccosteus* in greater detail.

The figure which I gave in that paper of the cranial shield is reproduced in Pl. XI., Fig. 2, with the addition of the dorsal cuirass. It is, I believe, accurate, and represents the result of a close study of a very great number of heads. Comparatively few specimens are, however, available for the purpose, those especially from Lethen and most of those from Orkney being ill-adapted for following the sutures separating the plates, while Cromarty and Edderton furnish those in which the surface is most perfectly preserved, thus affording the best opportunity for accurately distinguishing the true sutures from those superficial grooves which in past times have been so often confounded with them. Quite recently, however, the Edinburgh Museum has acquired a small collection of *Coccosteus*-remains from Stromness, in Orkney, in which the details of the surface of the cranial plates are most beautifully shown, and are entirely corroborative of the sketch which I published a year ago.

As I have previously stated (12, p. 511), I retain only two species of *Coccosteus* from the Scottish Lower Old Red Sandstone, namely *C. decipiens*, Ag., and *C. minor*, H. Miller, the differences which have led to the separation of "*oblongus*," Ag., "*cuspidatus*," Ag., *microspondylus*, *trigonaspis*, and *pusillus*, M'Coy, and *Milleri*, Egert., being dependent either upon the mode of preservation or upon trivial variations in the shape of certain plates, which are extremely common up to certain limits. That which I find especially difficult to understand is how Prof. von Koenen (10) should propose to

remove *C. Milleri*, Egert., and *C. pusillus*, M'Coy, from *Coccosteus* altogether, placing them in *Brachydeirus*, the fact being that they are simply synonyms of *decipiens*, Ag. *C. minor*, H. Miller, once mixed up with *C. pusillus*, M'Coy, may possibly have to be put into a new genus on account of the structure of the vertebral column, which presents an appearance as if possessed of ossified centra;¹ but I can see no reason for associating this species with v. Koenen's *Brachydeirus*.

The following description of the structure of the bony skeleton of *Coccosteus* is therefore based upon an examination of the common and well-known species *C. decipiens*, Agassiz.

Head.—In Pl. XI., Fig. 2, the bones forming the cranial shield are sketched, as well as the ramifications of the lateral-line grooves. These bones are:—one median occipital (*m. o.*), two external occipitals (*e. o.*), two central plates (*c.*), two marginals (*m.*), two post-orbitals (*pt. o.*), two pre-orbitals (*p. o.*), one posterior ethmoidal (*p. e.*), and one anterior ethmoidal (*a. e.*), between which last and the premaxillæ (*p. mx.*) the nasal openings (*n.*) are observable. I have already (13, p. 52) explained that I have applied those names without the intention of considering any of the bones exact equivalents of bones similarly named in ordinary fishes.

The orbit, the upper margin of which is formed by the excavated outer edges of the post- and pre-orbital buckler-plates, is completed below by the *superior maxillary* bone (*mx.*, Fig. 1), which strongly resembles in shape that of typical Palæoniscidæ in being broadly expanded behind, where it covers the cheek, and suddenly excavated to form a tapering process directed forwards under the eye to the premaxilla. To the posterior margin of the maxilla is fixed the *jugal* or post-maxilla, a triangular plate with posteriorly directed apex, which fills up the space between the maxilla and the lateral part of the body-cuirass.

So far as I can see, the maxilla of *Coccosteus decipiens* does not seem to have borne any teeth. But in a specimen from Gamrie in the Edinburgh Museum there is distinct evidence

¹ This is apparently the species "with a true bony vertebra" referred to by Murchison in "Siluria," 3rd ed., p. 504.

of the presence of both vomerine and palatal teeth. The specimen lies on its back, giving a beautiful view of the ventral cuirass, in front of which are the two rami of the mandible converging to meet each other anteriorly, while external to and in front of them the upper margin of the oral cleft is seen formed by the maxillæ and premaxillæ. No teeth are, as usual, seen on the maxillæ, but internal to them and between them and the contiguous mandibular ramus is seen a row of conical teeth, evidently placed on the edge of a palatal or palato-pterygoid bone, which I have not yet seen in its entirety. Also in front of the meeting of the mandibular rami and behind the premaxillary and ethmoidal region is a clump of five conical teeth, clearly vomerine in position at all events. It is also clear that the whole of the dentition of the front of the mouth is not here exposed, as the clump referred to is on the left side of the middle line, and the corresponding space on the right side is covered by the anterior extremity of the corresponding mandible.

The bone representing the mandible is well known from the description of Hugh Miller. It is an elongated, vertically-flattened plate (Fig. 1, *mn.*), broader behind than in front, with rounded posterior extremity, slightly sigmoid contour when seen from the side, and near the anterior extremity sharply bent inwards towards its fellow. It is remarkable for having two sets of conical teeth, one consisting of a row of about half-a-dozen being situated about the middle of the upper margin of the bone, while another row of about the same number occupies the vertical anterior margin, which would otherwise be *symphysial*. This is certainly a very curious circumstance, and one is simply at a loss to imagine of what use teeth could be in such a situation, or how they worked. It was indeed the position of these peculiar symphysial teeth that led Hugh Miller originally to compare the working of the jaws of *Coccosteus* with those of an Arthropod (2, 1st ed., p. 57; see also footnote in 4th and subsequent editions).

There are no traces of ossified internal cranial bones, of hyoid or of branchial arches; consequently these parts must have been entirely cartilaginous. I may mention that the

bones figured by Huxley as "the chief parts of the hyoidean arch" are in reality the ventral rami of the dermal plates which I have termed "interlateral."

Body-Cuirass.—The front part of the body behind the head is encircled by a girdle of osseous dermal plates, somewhat comparable to a shoulder-girdle, expanded backwards dorsally and ventrally, while at the lower part of the sides the cuirass is so deeply cut in that the dorsal and ventral expansions were long considered to have no connection with each other. Most of the osseous plates which form this cuirass are well known from the writings of Pander, H. Miller, and Sir P. Egerton, but nevertheless some correction is still necessary.

The great *median dorsal* plate (Fig. 2, *m. d.*) is of an elongated pentagonal figure, its short base articulating with the median and lateral occipitals, its acute apex and elongated sides articulating with the two dorso-lateral plates, which it extensively overlaps. Its under surface shows the well-known median longitudinal ridge, ending behind in the "nail-head" prominence, as in the corresponding plate in *Homosteus*. The *anterior dorso-lateral* plate (*a. d. l.*), the *os articulare dorsi* of Pander, is of a somewhat rectangular form when detached, though *in situ* it appears irregularly trapezoidal owing to its upper and lower margins being obliquely overlapped by the median dorsal and by the antero-lateral respectively; its anterior margin shows a small articular process by which it is joined to the external occipital. Immediately behind it is placed the *posterior dorso-lateral* (*p. d. l.*), or the *os triangulare* of Pander, a triangular plate which also articulates with the median dorsal above and the postero-lateral below, while its oblique hinder border is free.

The antero-lateral plate (*a. l.*), being the *os marginale* of Pander, occupies a position below and in front at the narrowest part of the lateral portion of the cuirass. It is peculiarly trapezoidal in shape, or it might be described as triangular, with the downward and forwardly directed apex obliquely truncated. Its anterior border, gently convex in the middle, forms part of the anterior margin of the cuirass,

though it is for the most part shut out from that by the anterior dorso-lateral above and the interlateral below; its postero-superior margin, somewhat wavy or zigzagged, overlaps the anterior dorso-lateral besides articulating with the small postero-lateral. The postero-inferior margin is free and slopes obliquely downwards and forwards; the short anterior margin is fitted on to the interlateral. This antero-lateral plate is the one lettered "c" by Huxley (8, p. 30) and "3" by Hugh Miller (7, p. 133, fig. 6), though he has represented the very same plate on the preceding page (p. 132, fig. 5, z z) as forming a part of the ventral cuirass.

The postero-lateral plate (*p. l.*) is a small one situated at the posterior angulated margin of the lateral part of the cuirass, and articulates with the antero-lateral, the anterior dorso-lateral, and the posterior dorso-lateral, its posterior margin being free. This plate is not noticed by Pander or Huxley, but it is lettered 2 by Hugh Miller (7, p. 133, fig. 6).

The *interlateral plate* (*i. l.*) is one of great interest, as its form and relations have not yet been properly recognised. It consists of two parts, lateral and ventral, united at a considerable angle to each other when uncompressed, which, however, is very rarely the case. The lateral portion, seen in Fig. 1, forms a sort of fork, on which the short inferior margin of the antero-lateral plate articulates, and thus is formed that connection between the dorso-lateral and ventral portions of the cuirass which was unknown to Pander and Huxley, and which, so far as I am aware, has not previously been demonstrated. The lower limb of the fork forms a conspicuous rounded lower margin, tuberculated like the other plates, and bears a most suspicious resemblance to the part represented by Prof. v. Koenen as a pectoral spine in *C. Bickensis* (10, pl. ii., fig. 2). In *C. decipiens* it is, however, very much shorter than the part alluded to in *C. Bickensis*; however, in *C. minor* it attains a very considerable proportional length (13, pl. iii., fig. 3, *i. l.*). The ventral portion (see Fig. 3), devoid of tubercular ornament, is elongated in shape, and, passing inwards and slightly forwards to meet its fellow of the opposite side, forms

the anterior margin of the ventral portion of the body-cuirass; to it posteriorly are articulated the anterior ventro-lateral and the anterior median plates. This part of the bone was known to Pander, and is represented in two of his figures (6, pl. ii., fig. 2, and pl. v., fig. 1, *x*), though in the text he compared it with the jugular plate in *Polypterus* or *Osteolepis*. Huxley, on the other hand (8, p. 35, fig. 21, *a*), considered the bone to be hyoidean in its nature, as we have already noticed.

Neither Pander nor Huxley seems to have recognised the lateral portion of this bone, which serves to articulate the dorso-lateral portion of the cuirass with the ventral; indeed, Huxley remarks (8, p. 32) that "the ventral shield appears to me to have had no connection with the dorsal." But of the connection of the two in the manner I have described there cannot be the slightest doubt. See also my figure of the parts in *C. minor* (13, pl. iii., fig. 3).

The plates forming the expanse of the ventral shield are already so well known from the figures of Pander and Hugh Miller, that I need hardly enter into detail regarding them, especially as I have in Pl. XI., Fig. 3, accurately given their respective shape and mode of overlap. They are six in number:—*anterior median ventral* (*a. m. v.*), *posterior median ventral* (*p. m. v.*), two *anterior ventro-laterals* (*a. v. l.*), and two *posterior ventro-laterals* (*p. v. l.*). I may, however, mention that, judging from the course of the lateral-line groove on the anterior ventro-lateral plate, Pander has reversed its position, putting the front end behind and *vice versa*; for we shall presently see that on this plate the sensory canal occurs on the anterior and not on the posterior part of its surface.

Distribution of the Lateral-line Grooves.—The course of the lateral sensory canal is indicated on certain of the dermal bones by conspicuous grooves, which, as in the case of *Pterichthys* and *Bothriolepis*, have often been mistaken for sutures. There is, however, no difficulty in distinguishing them from sutures, when one by experience really comes to know the characteristic appearance of the latter.

On the anterior half of each anterior ventro-lateral plate is

seen a curved groove, starting from near the middle of the anterior margin and then curving sharply round to proceed to the inner border close behind the antero-internal angle. On the median dorsal plate a groove is seen of a V-shaped contour, the apex being in the middle line somewhat in front of the posterior extremity of the bone, the limbs diverging forwards towards the superior margin of the posterior dorso-lateral plate. On the anterior dorso-lateral plate a continuation of this groove runs forwards to the postero-internal angle of the external occipital, near which it is met by a branch coming diagonally upwards and forwards from the postero-inferior angle of the plate. The side-canal thus formed passes now on to the cranial shield at the point indicated, and there at once gives off a branch running forwards and slightly inwards, parallel with and close to the outer margin of the median occipital, becoming lost on the posterior margin of the central. The main groove then runs forwards and outwards parallel with the outer margin of the shield, giving off first a branch passing to the external projecting angle of the marginal plate, then turning forwards and inwards still parallel to the shield-margin it passes on to the post-orbital plate, where it gives off another branch to the post-orbital angle. Here it bends sharply backwards and inwards at an acute angle, runs on to the central plate, approaching its fellow of the opposite side, and near the middle of this plate it again turns sharply forwards, passes on to the anterior part of the pre-orbital, and ends near the small nasal opening in front. In some specimens a cross commissural branch is seen on the central plates, connecting the two main trunks at the conspicuous angles which they make in that place.

A groove is also observable on the maxilla, apparently continued from the second external branch of the main groove on the post-orbital, and passing along as a sub-orbital branch close to the hollowed-out orbital margin of the bone. It gives off behind the eye another branch, which passes in a curved manner downwards and backwards towards the margin of the bone posteriorly.

Sclerotic Ring.—A specimen from Gamrie, in the Edinburgh

Museum, shows evidence of a sclerotic ring such as has been figured by v. Koenen (10, pl. ii, fig. 2; pl. iv., fig. 2).

Internal Skeleton.—In the typical *Coccosteus decipiens*, Ag., there is no trace of vertebral centra, the space occupied by the persistent notochord being always empty in the fossils. Agassiz in his restored figure (1, pl. vi, fig. 3) has represented on both dorsal and ventral aspects of the notochordal space a continuous row of distally-pointed neurapophyses and hæmapophyses, also a dorsal and anal fin situated opposite each other, each supported in Teleostean fashion by a series of proximally-pointed interspinous bones, dipping down between the neurapophyses, the supposed fin-rays being, according to the same idea, pointed at their extremities. Pander (6, pl. iv., fig. 1) still retains the two median fins, with the long hæmapophyses in front of the anal, though he was more correct in making the interspinous bones articulate end to end with the neurapophyses by expanded extremities. But though M'Coy had previously (5, p. 602) strongly doubted the existence of an anal fin in *Coccosteus*, Pander's figure has been copied into almost every text-book; Prof. von Koenen has transferred the body-skeleton and fins as there represented to his restoration of the allied genus *Brachydeirus*, while the anal fin is also mentioned as present by Zittel in his handbook (14, p. 160). M'Coy was, however, correct—there is no anal fin in *Coccosteus*; but besides this Pander's figure is incorrect in other points, which I shall now indicate.

It is not possible to trace the vertebral column to its commencement, owing to its obscuration by the dorso-lateral cuirass; where it first becomes visible is about the middle of the length of the great median dorsal plate. There we find short broad neural pieces continued obliquely backwards and upwards into neural spines, which gradually lengthen until we come to the dorsal fin, which commences a little beyond the apex of the plate just mentioned. Here we have two sets of interspinous bones articulated end to end with each other and with the neural spines, which latter are truncated and not pointed. In a very good specimen in the British Museum I count about fifteen ossicles in the proximal set and twelve

in the distal, though probably the numbers were equal in the perfect state, and in both sets they have the same form, namely, they are slender, elongated, and expanded at both extremities. It is evident from the last-mentioned circumstance that the ossicles of the second row are not dermal fin-rays, but belong to the same category as those of the first; two rows of interspinous bones being, in fact, of constant occurrence in the primitive Ganoids.

Beyond the dorsal fin the neural spines become very short as well as less oblique in their direction.

On the hæmal aspect of the vertebral axis no such elongated apophyses occur anteriorly, as depicted in the restorations of Agassiz and Pander. Immediately behind the lateral plates of the cuirass we find small, nearly circular, hæmal pieces *without spines*, then spines are added which, gradually lengthening, become longest in the region opposite the dorsal fin, whence they again diminish towards the extremity of the tail. It is this peculiar lengthening of the hæmapophyses under the dorsal, a fact also noticed by M'Coy, which has evidently given rise to the old idea of the presence of an anal fin.

. In all specimens of *Coccosteus* where the internal skeleton is well preserved there is found a pair of peculiar slender bones (*x*), each of which is pointed at both ends and bent below the middle at an obtuse angle in somewhat L-shaped fashion, the long limb pointing upwards towards the vertebral axis, the short one forwards. These bones were noticed by Pander (6, p. 73), who, though extremely doubtful as to their nature, supposed that they "vielleicht den Extremitäten als Stützen der weichen Flossen angehörten." Their position is certainly suggestive of their having had something to do with pelvic limbs—more I cannot say.

Mr A. Smith Woodward has pointed out to me that in several specimens in the British Museum a small oval or somewhat rhombic bony plate (*y*) is seen lying in a position posterior to the last-mentioned bones. I have not observed it in any other specimens than those; but its presence in a similar position in more than one example would seem to indicate that it was a scute placed in the ventral mesial line.

Were pectoral members present?—I have now examined with the utmost care a very great number of specimens of *Coccosteus decipiens* in all conditions of preservation and from all the beds and localities of the Scottish Old Red Sandstone which have yielded such remains, including the collections in the British Museum, in the Museum of Practical Geology, in the Edinburgh Museum of Science and Art, the Gordon-Cumming collection at Forres, and many others, but without meeting with any other parts either of endo- or exoskeleton than those I have described. And, in particular, I have not seen the smallest evidence of the presence of any pectoral limb, nor any trace of an articular surface on any of the bones to which such a limb could have been articulated. It can scarcely be believed that had such a limb been present it would either have escaped preservation or observation in so large a number of specimens. Nevertheless, more than one author has been disposed to believe in the presence of such a limb in *Coccosteus*.

In the restored figure of *Coccosteus* given by Hugh Miller in the first edition of the "Old Red Sandstone" (2, pl. iii.), no limb is represented, and its absence is positively affirmed in the text. But in subsequent editions, and also in Duff's "Geology of Moray" (3, pl. viii, fig. 1), a peculiar "paddle-shaped" body is represented appended to the head. However, Hugh Miller, in a footnote, explains that he has ascertained that the supposed arms "were simply plates of a peculiar form." Of course there is not the smallest doubt that the idea of this limb owed its origin to a displaced maxillary bone.

But more recently, in connection with what appear undoubtedly to be fragments of a large and peculiar form of *Coccosteus*, Trautschold (9 and 11) has described and figured from the Old Red Sandstone of Russia certain peculiar bodies, which he considers, though not without doubt, to appertain to supposed large arms or "Ruderorgane" belonging to that species, which he accordingly names *Coccosteus megalopteryx*. What the fragments are to which he applies the term "Oberarm" I have not the slightest idea, as I have not seen them, and certainly nothing like them has ever

been found along with *Coccosteus decipiens*. But with regard to the peculiar flat triangular bodies represented in his first memoir on the subject (9, tab. vi. and tab. vii., fig. 2), I have had the privilege of examining two specimens contained in the British Museum.

In the first place there is no evidence whatever that these bodies belong to *Coccosteus* at all, any more than the supposed "Oberarm," as nothing in any way resembling them has ever been seen in connection with the most perfect specimens of *C. decipiens*, the type of the genus, which the Scottish Old Red Sandstone has afforded. Prof. v. Koenen has also expressed grave doubts (10, Supplementary Note) as to their having belonged to *Coccosteus*, though he thinks it not impossible that the piece referred to as "Oberarm" may be identical with the "stabförmiges Ruderorgan," the existence of which he himself maintains.

In the second place it seems to me highly probable that they are Selachian appendages; indeed, their form and appearance is strongly suggestive of an affinity with *Oracanthus*, which is certainly Selachian, although some years ago Mr J. W. Davis was inclined to refer it to the Placodermi, though *not* as a pectoral limb. These so-called "Flossen" are flat bodies, of a horn-shaped outline, pointed, with one margin convex, the other concave, truncate base, and rounded lateral edges. A great part of the surface is sculptured with closely-set tubercles, which are occasionally irregularly elongated, and all with stellate bases; these tubercles being an integral part of the substance of the appendage, the term "Schuppenhaut" applied to them by Prof. Trautschold seems hardly appropriate. The basal margin of the body is not tuberculated but striated, and this striated portion extends further up on one side than on the other.

Now, Prof. Trautschold admits (11, p. 36, note) that the body figured by Pander as an "*ichthyodorulithe*" (6, pl. vii., fig. 22) is identical with the end of one of the supposed "fins" of *Coccosteus megalopteryx*; and if so, then its microscopic structure is not that of a Coccostean bone, but of a Selachian appendage. For here are the words in which

Pander refers to the body in question:—"Fig. 22. Ein *Ichthyodorulithe*, mit ausgezeichnet schönen Sternen auf beiden Flächen und Kanten. Die Sternchen sind äusserlich von denen von *Asterolepis*, *Coccosteus* und *Homosteus* unmöglich zu unterscheiden, aber die microscopische Structur ist ganz verschieden. Knochenhöhlen fehlen gänzlich. Die Tuberkel bestehen aus wahrer Dentine und die ganz innere Masse aus einem Gewebe von Markcanälen, umgeben von concentrischen Kreisen, in der Grundsubstanz, welche von den nach allen Seiten ausstrahlenden feinen Zahnröhrchen unter rechten Winkeln durchschnitten werden" (6, pp. 102, 103). From this description, along with Pander's figure of the microscopic structure (*ib.*, fig. 34), the true nature of these bodies is, I think, pretty evident.

I am therefore quite unable to accept Prof. Trautschold's views as to the "fins" of *Coccosteus*.

But, as already mentioned, Prof. von Koenen has affirmed the presence in *Coccosteus* of a "Ruderorgan," and in his restored figure of his "subgenus" *Brachydeirus* (10, pl. iv., fig. 1) he has represented the same as a long, pointed spine diverging backwards from the antero-inferior angle of the antero-lateral plate of the cuirass. In tab. ii., fig. 2, of the same work he has also represented the spine *in situ* in a specimen of *Coccosteus Bickensis*, v. Koen.; but the supposed spine is here much shorter than in the restoration, and lies horizontally just below the antero-lateral plate, in the very spot where the outer margin of the interlateral plate occurs in Scotch specimens of the genus. I have already stated that the appearance here is strongly suggestive to my mind that this "Ruderorgan" or pectoral spine is nothing but the outer *Kante*, as the Germans would call it, of the interlateral plate. But though the corresponding part in *C. decipiens* is very much shorter than that here represented, it attains a very considerable proportional length as well as a *very spine-like appearance* in *C. minor*, H. Miller, as is shown in my outline figure of that species (13, pl. iii., fig. 3). That it should also attain similar proportions in other species is highly probable.

Of course I have not seen Prof. v. Koenen's specimens, and

it is not always safe to judge from figures and descriptions alone. This much I am, however, entitled to say—that if such a pectoral swimming-organ really does occur in Prof. v. Koenen's species *Bickensis*, that species cannot be referred to *Coccosteus*, in which no such organ is present. And, again, if it is present in *Brachydeirus bidorsatus*, v. Koen., then *Brachydeirus* is not merely a "subgenus" of *Coccosteus*, but a genus with a very great distinction indeed.

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EXPLANATION OF PLATE.

(In all the Figures the same letters refer to the same things.)

<i>m. o.</i> Median occipital.	<i>m. d.</i> Median dorsal.
<i>e. o.</i> External occipital.	<i>a. d. l.</i> Anterior dorso-lateral.
<i>m.</i> Marginal.	<i>p. d. l.</i> Posterior dorso-lateral.
<i>c.</i> Central.	<i>a. l.</i> Antero-lateral.
<i>pt. o.</i> Post-orbital.	<i>p. l.</i> Postero-lateral.
<i>p. o.</i> Pre-orbital.	<i>i. l.</i> Interlateral.
<i>pt. c.</i> Posterior ethmoidal.	<i>a. m. v.</i> Anterior median ventral.
<i>a. c.</i> Anterior ethmoidal.	<i>m. v.</i> Median ventral.
<i>p. mx.</i> Premaxillary.	<i>a. v. l.</i> Anterior ventro-lateral.
<i>n.</i> Nasal opening.	<i>p. v. l.</i> Posterior ventro-lateral.
<i>mx.</i> Maxillary.	<i>x.</i> Peculiar internal bones.
<i>j.</i> Jugal.	<i>y.</i> Posterior ventral plate.
<i>o.</i> Orbit.	<i>mn.</i> Mandible.

Fig. 1. Restored outline of the skeleton of *Coccosteus decipiens*, Agassiz. The dotted lines indicate the ramifications of the lateral-line system; the thin lines on the body-cuirass here and in Fig. 3 denote the overlapped edges of the plates.

Fig. 2. View of the head and dorso-lateral portion of the body-cuirass from above.

Fig. 3. View of the ventral portion of the body-cuirass from below. The thin lines denote the overlapped edges of the plates.

XXIII. *On an Exhalation of Gases, under singular circumstances, from a Bog near Strathpeffer.* By HUGH MILLER, Esq., F.R.S.E.

(Read 15th January 1890.)

For the information which led to my inquiries into the facts of this curious case, I am indebted to Mr Hossack of the Crofter Commission.

Two and a half years ago, in the summer or autumn of 1887, a curling pond was constructed in the grounds of Fairbairn Castle (John Stirling, Esq. of Fairbairn) on the banks of the River Orrin, not far from Strathpeffer. The pond was made in the heart of a peat bog. Its sides were bordered by a stone embankment; its bottom still rested on the soft peat, of which quantities were, of course, taken out during its excavation. The winter came, and with it a season of frost, but the ice was of no use whatever for skating upon. It was found to be spotted and flawed in every direction with multitudes of flat bubbles of every size, many of them as large as a dinner plate or a small ashet. When these bubbles were broken or punctured there was an escape of gas with a slight hiss or roar. Someone thought of applying a light to the escaping gas. Instantly there was a jet of flame, described to me as rising with a kind of explosion, in some cases as much as five feet into the air. Here then, it was thought, was Will-o'-the-Wisp actually ice-bound, and the case seems to have excited considerable interest among the intelligent occupiers of the castle. But all prospects of a winter's curling were disappointed.

On the following winter when I visited, and made inquiries on the spot, the bubbles were described as having been much smaller, and the exhalations were supposed to be wearing out, but there had been almost no frost. My visit took place in the middle of December 1888. The pond lies about a quarter of a mile south from the castle. The bog, which it had partly replaced, occupied the lowest terrace of the Orrin, only a few yards from the river, and not more than about eight feet above its bed. The stream

at this point runs over gravel. There is no exposure of the conglomerate of the Old Red Sandstone (the "Great Conglomerate" of my father's writings), which probably forms the underlying rock. The place is apparently one of these opener basins common on our older valleys where the hollow is thickly lined with boulder-clay, and is easily cut into river terraces, each covered as usual by a sheet of river-gravel. One raw scar of grey boulder-clay showed, like the mark of a fresh landslip, on the opposite bank; traces of the terrace gravel of the mountain stream could be seen near the water's edge. The remnants of the bog surround the walk which encircles the pond.

The peat is "young," or raw and imperfectly formed: the vegetation forming it appeared to be still in an actively decomposing condition: the pools were clouded with hydrous oxide of iron, like a suspended sediment of burnt sienna. A string of bubbles rose now and then from the bottom of the pond, which, when I saw it, had become green with grassy weeds. It was plain that when prevented from breaking at the surface by a film of ice the bubbles had been frozen-in—imprisoned, and perhaps compressed, by the formation of new ice underneath them.

It would have been of interest to obtain samples of this gas for analysis, and my friend, Professor Ivison Macadam, has furnished me with an apparatus for the purpose, at present placed in the hands of Mr Morrison, the well-known rector of the Dingwall Academy, who has kindly undertaken, subject to the consent of the proprietor of the castle, to visit the spot for the purpose. But since my visit in 1888 there has been no skating; and it is possible that, as supposed by observers on the spot, the exhalations may be exhausting themselves.

The explosive character of the gas when issuing into the air identifies it as largely consisting of marsh gas,—the explosive fire-damp of the coal pits,—the cause of what is known as *singing* coal, and of blowers in petroleum springs. Mingled with it are doubtless other gases—nitrogen, carbonic acid (unless absorbed by the water), perhaps some olefiant gas, and probably a little sulphuretted hydrogen (which, however, would be absorbed at once), which I have observed to be

also a product of peat bogs. Whether we succeed in "sampling" the Fairbairn exhalations or not, the circumstances of the case at least suggest an easy method of collecting bog gases in the future. I have heard of a Glasgow Professor of Chemistry, in the early part of the century, I believe, who was in the habit of taking the members of his class out with him into boggy ground armed with bottles to catch the bubbles as they rose in silvery little chains from the bottom of the pools. But here we have suggested a simpler method. The bubbles can be carried home in the ice, immersed in warm water, and collected on liberation.

XXIV. *On Phlyctænaspis, a new Genus of Coccosteidæ.*¹ By
Dr R. H. TRAQUAIR, F.R.S., F.G.S. [Plate XII.]

(Read 15th January 1890.)

In the *Geological Magazine* for this month (January) I proposed to establish the genus *Phlyctænius* for the peculiar Coccostean from the Lower Devonian beds of Campbelltown in Canada, named by Whiteaves *Coccosteus Acadicus*. In this paper I propose describing that form more in detail, along with an allied, though at the same time very strongly marked, species from the Lower Old Red Sandstone of Herefordshire, to which on that occasion I also referred. The name *Phlyctænius* having been found to be pre-occupied, I have altered it to *Phlyctænaspis*.²

Mr Whiteaves apparently did not recognise the extent of the differences between this species and the true *Coccosteus* of the Scottish Old Red; but this I think he would have done, had he succeeded more thoroughly in deciphering the arrangement of the plates of the cranial buckler. As it is, he seems almost to hesitate as to whether it is specifically distinct from *Coccosteus cuspidatus* of Agassiz. "In some respects," he says, "the Campbelltown *Coccosteus* very closely resembles the *C. cuspidatus* of Agassiz, but in others there are such

¹ Appeared also in the *Geological Magazine*, Decade III., Vol. VII., No. 308, p. 55, February 1890.

² The name *Phlyctænius* was used in the paper as read before the Society and printed in the *Geological Magazine*. It was altered to *Phlyctænaspis* in a note published in the same magazine for March 1890.

marked differences between the two forms that it is thought more prudent, for the present, to distinguish the Canadian species by a local name." He notices the similarity in the arrangement of its "superficial" (*i.e.*, sensory) grooves with those of *C. decipiens*, Ag., and finishes by saying: "It would seem, therefore, that *C. Acadicus* may be distinguished from *C. decipiens* by the different shape of the post-dorso-median plate, from *C. cuspidatus* by the different arrangement of the grooves on the outer surface of its cranial shield, and from both by the peculiar sculpture of its bony plates."¹

It is, therefore, evident that Mr Whiteaves was unaware that *C. cuspidatus* is nothing but a mere synonym of *C. decipiens*, and that he also makes no allowance for the fact that Hugh Miller's figure on plate iii. of the "Old Red Sandstone," from which he seems to derive his information as to the character of this supposed species, is only an imperfect restoration of *C. decipiens* executed at a time when our information on such matters was still rather undeveloped.

The cranial shield of *Phlyctænaspis Acadicus* (Plate XII., Figs. 1, 2) must have been considerably vaulted from side to side, as the specimens, now much flattened, not unfrequently present irregular longitudinal fractures. The form is broadly ovate, truncated behind with prominent *postero-lateral* angles (P.L.). In front of the *postero-lateral* angle the margin passes obliquely outwards and forwards for a short distance, and then forms another obtuse angle, the *postero-external* (P.E.), succeeded by a shallow notch, in front of which is the *antero-external* angle (A.E.). Immediately after this the direction of the margin is forwards and slightly inwards to what may be called the *post-orbital* angle (P.O.), whence proceeding more strongly inwards, it forms a slightly excavated edge, evidently equal to the orbital excavation of the shield of *Coccosteus*, and bounded in front by the *ante-orbital* angle (A.O.). Between the *ante-orbital* angles of opposite sides, the margin of the shield is completed in front by a shallow concavity occupied in the perfect state by the "rostral" plate as shown by Mr Whiteaves.

Leaving the sensory groove system out of consideration for

¹ Trans. Roy. Soc. Can., vol. vi., sect. iv., 1889, p. 93.

the present, it is first to be noticed that the determination of the constituent plates of the buckler is a matter of extreme difficulty, from the fact that they are apparently all fused or anchylosed together in the manner in which those of the shield of *Pteraspis* are in the adult form supposed to be. Mr Whiteaves has noticed the frequent arrangement of the tubercles in concentric rows, and this arrangement, much more marked in some shields than in others, along with the lines seen to radiate from the ossific centres in abraded specimens, first led me to suspect that the form and arrangement of the cranial plates differed in some material points from what is given in Mr Whiteaves' sketch.¹ Close observation by means of a good lens enables one, however, also to observe the original lines of suture, due care being taken not to be deceived by fractures. Though the direction of these sutures is often indicated by depressed lines or slight grooves free from the tubercular ornament, yet the actual suture is not incised, but *slightly raised* like a very fine thread, this being due to the manner in which the original lines of separation between the bones have become entirely filled up by osseous matter.

The results obtained by noting these lines in connection with the concentric arrangement of the rows of tubercles being in all essential respects the same in all the specimens (six) which I have examined, and being furthermore in complete accordance with the information derived from the lines radiating from the ossific centres in a specimen with the surface rubbed off, there can be no doubt that the true form and arrangement of the constituent plates of the shield has been arrived at. The pattern in two shields has been represented in outline in Pl. XII., Figs. 1 and 2, and if the reader will compare these figures with that which I have already given of the cranial shield of *Coccosteus*,² the fundamental agreement as well as the essential difference between the two will at once be perceived.

The *median occipital* plate (*m.o.*) is more or less five-sided, elongate, truncated behind, pointed in front, where it is

¹ *Op. cit.*, p. 93, woodcut.

² *Geol. Mag.*, Dec. III., vol. VI., pl. I., fig. 2.

wedged in between the hinder thirds of the two centrals. Its ossific centre is near the posterior margin, and is marked by a prominent elevation of the surface. On each side of the median occipital is placed the *external occipital* (*e.o.*), which, although differently shaped from that in *Coccosteus*, forms, as in that genus, the postero-external angle (P.E.) of the shield. In front of these three occipital plates, and occupying a position in the middle of the shield rather nearer the front than the back, are the two *central* plates (*c.*), whose difference of form from those of *Coccosteus* is equally striking, as is the case of the median occipital. They are more or less of an ovate-oblong, approximating to an elongated hexagonal form, articulating in the middle line with each other and round about with all the other plates of the shield except the rostral or anterior ethmoidal. The *marginal* plate (*m.*) is situated on the outer side of the central in front of the lateral occipital, and forms the antero-external angle of the shield (A.E.); in front of it is the post-orbital (*pt.o.*), which forms the post-orbital angle (P.O.), and the posterior part of the orbital margin. The front of the shield is now filled in by the pre-orbital plates (P.O.) which meet in the middle line, form the ante-orbital angle, part of the orbital margin on each side, as well as the anterior median shallow excavation, in which the plate named "rostral" by Whiteaves fits. This rostral plate is not present in any of the specimens in the Edinburgh Museum, but its form and position in the specimen figured by Whiteaves,¹ render it evident that it corresponds with the *anterior ethmoid* in *Coccosteus*.

Some amount of variation is observable in the form of these shields as well as of their component plates. Fig. 2 represents the configuration of a specimen which is proportionally shorter and broader than usual, and in which also the median occipital plate advances further forwards between the centrals, which are more irregular in shape, and have their long axes divergent backwards.

The arrangement of the lateral line system corresponds in the main with that in *Coccosteus*. The lateral groove com-

¹ *Op. cit.*, pl. ix., fig. 1.

mences on each side in the external occipital plate near the postero-lateral angle of the shield. Running forwards and slightly outwards, it passes on to the marginal plate, where it gives off a branch backwards and outwards to the edge of the shield just behind the postero-external angle. The main groove then turns forwards and slightly inwards at an obtuse angle, and on passing on to the post-orbital turns on the middle of that bone acutely backwards and inwards, ending on or near the centre of ossification of the central plate. Just at the point where the backward turn commences, a short branch is given off which ends in the post-orbital angle or prominence.

Mr Whiteaves represents the main groove as again continued forwards at an acute angle so as to end at the front of the shield near the ante-orbital prominence. Judging from analogy with *Coccosteus*, one might expect it to do so, but this continuation is not exhibited in any of the specimens which I have examined.

Associated in the same deposit with the cranial shields are found various other isolated plates, which from their sculpture probably belong to the same fish. Of these the only one which seems to be clearly identifiable is the median dorsal plate (Whiteaves, *op. cit.*, pl. ix., fig. 2). The plate which he has figured as "left pre-ventro-lateral" (*ib.*, fig. 3), if it is so, must belong to the right side of the body, but his "ventro-median (?)" cannot be referable to a median position, as it is unsymmetrical. The Edinburgh Museum possesses a number of such detached plates of different forms, but I am certainly not prepared to speculate at present as to their position on the body cuirass. One thing is at least evident, namely, that if those plates really belong to *Phlyctænaspis*, their difference of form from those of *Coccosteus* certainly gives additional emphasis to the distinctness of the genus. No trace of the maxillæ or mandibles of *P. Acadicus* has, so far as I am aware, been yet discovered.

Phlyctænaspis Anglicus, sp. nov.

A good many years ago a small lot of fossils from Herefordshire was purchased from a London dealer for the Edin-

burgh Museum, and among them I found a small cranial shield, which, being obviously referable neither to *Cephalaspis*, nor to *Pteraspis*, nor to *Scaphaspis*, was rather puzzling in its appearance. Being, however, at the time specially engaged with other subjects, this shield, from Cradley, lay rather neglected, till one day I bethought me of it when examining our collection of fish remains from the Devonian rocks of Canada, and I was then greatly interested to find that the English fossil was in reality a *Coccostean*, and a *Coccostean* not of the type of *Coccosteus decipiens*, but of *Phlyctænaspis Acadicus*. This is of special geological interest, seeing that both in England and Canada this type is associated in the same beds with *Cephalaspis*, whereas not a trace of any Cephalaspidean has ever occurred in those northern Old Red Sandstone deposits (Orkney, Caithness, and Moray Firth) in which the typical *Coccosteus* is abundant. Nor does *Coccosteus* occur in Forfarshire, where *Cephalaspis* is characteristic.

At the time I made this discovery no one seemed to know of the existence of a *Coccostean* in the Cradley beds, though indeed a piece of the shield of this very species is figured by Lankester in his "Monograph of the Cephalaspidæ" (pl. viii, fig. 4) as a "fragment of doubtful character" in connection with *Zenaspis Salweyi*.¹ However, a short time after communicating with Mr Smith Woodward on the subject, I received a letter from that gentleman informing me that he had since discovered, in the stores of the British Museum, quite a number of specimens apparently identical with that to which I had referred. He also kindly forwarded to me a plaster cast of one of them, as well as outlines in pencil of two others.

In Pl. XII., Fig. 3, I have given a sketch of the specimen in the Edinburgh Museum. It measures $1\frac{3}{4}$ inches in length, and in general form resembles the cranial shield of *P. Acadicus*, except that at the back it is more produced outwards, as in *Coccosteus*, the postero- and antero-external

¹ Mr Wm. Davies seems to have believed in the occurrence of "Placodermi" in the Herefordshire beds, as he labelled some fragments in the British Museum "*Pterichthys*." They do not, however, belong to that genus.

angles being confluent into one of considerably greater prominence. In front we have the same more anterior direction of the orbital excavations, bounded by the post-orbital and ante-orbital prominences, and between the latter (of each side) we have a similar gentle concavity for the rostral or ethmoidal plate.

It is the internal or concave aspect of the shield which is here exhibited, and it is extremely difficult to recognise any sutures except that separating off the median occipital, which shows distinctly enough that this plate had the same elongated pointed form as in the Canadian species. The bone being considerably splintered away, especially on the right side, some of the external markings are seen in impression, showing that the surface was sculptured with tubercles of a comparatively large size. The course of the lateral-line groove may be distinctly enough seen, its disposition being quite similar to that in *P. Acadicus*,—the main groove, starting in the external occipital, passing obliquely forwards and inwards to the ossific centre of the plate, then proceeding forwards and slightly outwards for a little distance, and sending a branch obliquely backwards and outwards to the external angle of the shield, after which it proceeds forwards and slightly inwards to behind the postero-orbital angle. There, a ridge on the inner surface of the shield indicates that it turns at an acute angle backwards and inwards to the middle of the central plate in a manner quite similar to that already seen in *P. Acadicus*.

Figure 4 is a diagram-sketch of the plaster cast sent me by Mr Smith Woodward, taken from a specimen which clearly belongs to the same species, and which shows many points with greater clearness than that belonging to the Edinburgh Museum, the outer surface being here displayed. It measures two inches in length by two in breadth, but has a piece broken off at the posterior part of the left side, while on the right it looks as if the prominent external angle were covered by the matrix. The surface is covered by a coarse pustular tuberculation, omitted in the figure, showing at places a little, but not much, of the concentric arrangement ;

the course of the lateral-line grooves is clearly discernible, while the form and arrangement of the constituent bones may be pretty fairly made out, both by actual indications of sutures as well as by radiating lines where the surface has been abraded. It is clear also, from both specimens, that these bones were quite fused or anchylosed together, and in the cast now under description the sutures are sometimes indicated by delicate raised lines as in *P. Acadicus*. I have indicated in the sketch the course of the divisions between the plates, naturally in a somewhat exaggerated manner, as the lines themselves are only visible by a lens, and often cannot be followed at all. But from what is seen it is quite clear that the plates were similar in general form and arrangement to those in *P. Acadicus*, and especially to those in the specimen represented in Fig. 2, the median occipital extending far forwards and the centrals being rather truncated in front.

One of the pencil outlines sent to me by Mr Smith Woodward shows apparently the rostral or ethmoidal plate *in situ*, thus completing the generic resemblance between the Canadian and English species.

We may therefore sum up the results of the preceding investigations as follows:—

Genus *Phlyctœnaspis*, Traquair. Cranial shield more ovate than in *Coccosteus*: constituent plates anchylosed, except the ethmoidal; median occipital elongated, pointed in front and wedged in between the posterior ends of the oblong or ovate central plates; orbital excavation looking more anteriorly than in *Coccosteus*; course of main lateral-line groove nearly straight from the external occipital to the post-orbital, where it is very acutely bent backwards. Plates of body-cuirass imperfectly known.

1. *P. Acadicus*, Whiteaves sp. External angle of cranial shield divided by a shallow notch into two, the postero- and antero-external angles; surface ornamented by fine tubercles, in most specimens showing a concentric arrangement parallel to the margin of the constituent plates. Lower Devonian, Canada.

2. *P. Anglicus*, Traquair. Postero- and antero-external

angles confluent, surface covered by a coarse pustulation. Cornstones, Herefordshire.

In conclusion, my most hearty thanks are due to Mr Smith Woodward for the information he has afforded me regarding the Herefordshire specimens in the British Museum, and to Dr Woodward, F.R.S., for permission to make use of the plaster cast taken from one of these specimens.

EXPLANATION OF PLATE.

In all the figures the same letters refer to the same things.

P.L. postero-lateral angle. P.E. postero-external angle. A.E. antero-external angle. P.O. post-orbital angle. A.O. ante-orbital angle. *m.o.* median occipital. *e.o.* external occipital. *c.* central. *m.* marginal. *pt.o.* post-orbital. *p.o.* pre-orbital. *e.* ethmoidal.

Fig. 1. Restored outline showing the arrangement of the plates and lateral-line grooves in the cranial shield of *P. Acadicus*, Whiteaves sp.

Fig. 2. The same in another specimen, lateral margins of the shield restored in dotted outline.

Fig. 3. Sketch of a specimen of the cranial shield of *P. Anglicus*, Traquair, from a specimen in the Edinburgh Museum.

Fig. 4. Sketch of a plaster cast of another specimen, contained in the British Museum, the surface ornament being omitted.

XXV. *The Classification and Distribution of Earthworms.* By FRANK E. BEDDARD, M.A., F.R.S.E., F.Z.S., Prosector and Davis Lecturer to the Zoological Society of London; Lecturer on Biology at Guy's Hospital. [Plates XIII., XIV.]

(Read 19th February and 19th March 1890.)

PART I.—CLASSIFICATION.

As I have taken pains—in common with most recent writers—to point out that the Oligochæta cannot be divided into two divisions, it may seem irrational to consider the classification of the "*Terricolous*" forms apart from that of the "*Limicolous*." But as a matter of fact, it seems to me that, although it is quite impossible to contrast two such groups as "*Oligochæta terricolæ*" and "*Oligochæta limicolæ*," it is

necessary to consider the terricolous forms as forming two groups, which are each equivalent to various groups, such as Tubificidæ, etc., into which the limicolous forms may be suitably divided. To a certain extent, therefore, it will be seen that my views accord with those recently expressed by Rosa;¹ but before criticising the scheme propounded by the Italian naturalist and expounding my own, it may be useful to give a short *résumé* of previous opinions.

It is impossible to commence earlier than Perrier,² whose views were the result of the study of a larger number of forms than had been previously investigated by any one of his predecessors except Kinberg.³ But Kinberg's scheme of classification cannot be considered seriously, as it took account only of certain external characters, the number and arrangement of the setæ, and one or two other points of even less importance. The reader is therefore referred at once to Kinberg's paper, or to an abstract of it, in vol. iii. of the "Zoological Record" (p. 597).

M. Perrier, distinguishing earthworms as a group equivalent to that of the rest of the Oligochaeta,² divided them into three divisions, mainly fixed by external characters, which were believed, however, to be in harmony with internal organisation—

(1.) Lombriciens Anteclitelliens—

Male reproductive pores *in front* of clitellum.

(2.) L. Intracitelliens—

Male reproductive pores *within* clitellum.

(3.) L. Postclitelliens—

Male reproductive pores *behind* clitellum.

To these three a fourth—L. Aclitelliens, to include *Moniligaster*, *without* a clitellum—was somewhat doubtfully added.

Later on, M. Perrier⁴ expressed himself with regard

¹ Nuova Classificazione dei Terricoli—Boll. Mus. Zool. Torino, No. 41, vol. iii. (1888).

² Mémoires pour servir à l'histoire des Lombriciens terrestres—Nouv. Arch. d. Mus., t. viii. (1872).

³ Annulata nova—Öfv. af K. Vet. Akad. Förh., 1866, p. 97.

⁴ Études sur l'Organisation des Lombriciens terrestres: iv. Organisation des Pontodrilus [E. P.]—Arch. de Zool. Exp., t. ix., 1881, p. 236, note.

to the connection between the Intracitellians and Postcitellians as follows:—" *Eudrilus*, which we have placed, in our *Recherches pour servir à l'histoire des Lombriciens terrestres*, among the intracitellian earthworms, appears to be transitional between this group and that of the *Postcitellians*, if we only consider the extent of the clitellum, which in our species is prolonged beyond so as to reach the male reproductive pores; in reality, their organisation is that of the '*Postcitellians*,' and we should place them at the head of that group immediately after the Intracitellians."

The points to which M. Perrier refers here are chiefly the atria, which he compares in the text to those of *Pontodrilus*.

Further researches did not tend to confirm the naturalness of Perrier's classification, except as regards the first and fourth groups.¹ I myself have pointed out that *Megascolex cæruleus*,² otherwise so closely allied to *Perichaeta*, has "intracitellian" male reproductive apertures.

Acanthodrilus is a genus of which, according to Horst, Perrier, myself, and others, some species ought to be referred to the *second*, others to the *third*, of Perrier's groups as defined above.

Other instances of a like kind show that a hard and fast line cannot be drawn between the Postcitellians and the Intracitellians as regards the extent of the clitellum.

M. Perrier's classification has been attacked, and, in so far as he laid most stress upon the relations of the male pores to the clitellum, justly attacked, according to my way of thinking.

It will be noticed, however, in the course of the present paper, that all his groups—after removing only the Eudrilidæ—are perfectly natural assemblages if they are regarded from other points of view, to some of which, indeed, such as the presence of atria, he refers himself. One of the principal relations upon which I insist in this paper is the necessary

¹ Dr Rosa himself (*loc. cit.*, p. 9) regards the Moniligastridæ as a distinct family.

² On the Anatomy and Histology of *Pleurochaeta Moseleyi*—Trans. Roy. Soc. Edin., vol. xxx.

association of the Acanthodrilidæ, Perichætidæ, and Perrier's genera *Digaster* and *Pontodrilus*.

Impressed by these facts, I ventured¹ to contrast the Antecitellians on the one hand with the Intra- and Post-clitellians on the other. Our increased knowledge of the group does not, as it appears to me, favour such an arrangement.

Professor Claus' classification,² being essentially that of Perrier, needs no special mention.

M. L. Vaillant³ places all earthworms in one family—Lumbricidæ—which includes, besides various rather doubtful genera, *Phreoryctes*. Although this genus has undoubted affinities to earthworms, I do not think it permissible to unite it in the same group with them.⁴

The various genera of Lumbricidæ which Vaillant admits, include a number that are very doubtful, such as *Helodrilus*, Hoffm., *Hypogaeon*, Sav., *Pontoscolex*, Schm. As to any further grouping of these genera, he says (p. 60), "La division du groupe ne me paraît pas devoir comporter l'établissement de familles, malgré l'opinion contraire de M. Vejdovsky, lequel y ajoute celles des Pleurochætidæ, Plutellidæ, Criodrilidæ, Pontodrilidæ, les caractères sur lesquels elles sont établies ne peuvent être regardés comme ayant une valeur suffisante, car ils ne conduisent pas à des rapprochements qu'on puisse réellement regarder comme naturels. Aussi, tout on les employant dans l'énumération synoptique ci-contre, je ne crois pas qu'ils puissent encore servir à autre chose, qu'à établir un système pour arriver à la détermination des genres."

Vejdovsky⁵ introduced a considerable number of improvements into the current schemes, although, as will be pointed out directly, his scheme is not thoroughly in accord with our present knowledge. His classification is as follows :—

¹ Descriptions of some new or little known Earthworms—P. Z. S., 1886, p. 312.

² Grundsätze der Zoologie, 2d ed. Marburg, 1880.

³ Histoire Naturelle des Annelés, marins et d'eau douce. Paris, 1889.

⁴ BEDDARD, The Anatomy, Histology, and Affinities of *Phreoryctes*—Trans. Roy. Soc. Edin., vol. xxxv.

⁵ System und Morphologie der Oligochæten. Prag, 1884, p. 63.

Pontodrilidæ, Vejd.

Pontodrilus, E. P.

Criodrilidæ, Vejd.

Criodrilus, Hoffm.

Lumbricidæ, Vejd.

1. *Tetragonurus*, Eis.
2. *Allurus*, Eis.
3. *Dendrobæna*, Eis.
4. *Allolobophora*, Eis.
5. *Lumbricus*, L.
- ? 6. *Hypogæon*, Sav.
- ? 7. *Alyattes*, Kinb.

Eudrilidæ, Claus (= *L. intracitelliens*, E. P.).

1. *Eudrilus*, E. P.
2. *Rhinodrilus*, E. P.
3. *Anteus*, E. P.¹
4. *Titanus*, E. P.
5. *Geogenia*, Kinb.
6. *Urochæta*, E. P.
7. *Typhæus*, Beddard.
- ? 8. *Pontoscolex*, Schmarda.

Acanthodrilidæ, Claus.

1. *Acanthodrilus*, E. P.
2. *Digaster*, E. P.
- ? 3. *Mandane*, Kinb.

Perichætidæ, Claus.

1. *Perichæta* (Schmarda), Beddard.
2. *Perionyx*, E. P.

Plutellidæ, Vejd.

Plutellus, E. P.

Pleurochætidæ, Vejd.

Pleurochæta, Beddard (? = *Megascolex*, Templ.).

Moniligastridæ, Claus.

Moniligaster, E. P.

Rosa has criticised this classification, and for the most

¹ Vaillant (*Histoire Naturelle des Annelés, marins et d'eau douce*, Paris, 1889, p. 183, *et seq.*) unites *Anteus* and *Microchæta*. The very remarkable spermathecae of the latter genus, which are also found in *Brachydrilus*, seem to be against such an identification. His generic definition, created for the inclusion of these two forms, seems to me to be not sufficiently precise.

part I agree with his criticisms. But it must be remembered that it expressed the knowledge of the time, in, as I think, a very satisfactory fashion. I reserve further remarks until after writing down Rosa's scheme, which is as follows:—

Lumbricidæ.

Lumbricus, Eis.¹
Allolobophora, Eis.
Allurus, Eis.
Tetragonurus, Eis.

Geoscolecidæ.

Geoscolex, Leuck.
Anteus, E. P.
Thamnodrilus, F. E. B.
Microchaeta, F. E. B.
Urobenus, Benham.
Urochaeta, E. P.
Diachaeta, Benham.
Hormogaster, Rosa.
Rhinodrilus, E. P.
Geogenia, Kinb.
Tritogenia, Kinb.

Moniligastridæ.

Moniligaster, E. P.

Acanthodrilidæ.

Acanthodrilus, E. P.
Trigaster, Benham.

Eudrilidæ.

Eudrilus, E. P.
Typhæus, F. E. B.
Microscolex, Rosa.
Photodrilus, Giard.
Pontodrilus, E. P.
Digaster, E. P.
Notoscolex, Fletch.²
Didymogaster, Fletch.

¹ Only the generic names printed in "Clarendon" in the author's list are given here.

² *Notoscolex*, according to Spencer (The Anatomy of *Megascolides australis*—Trans. Roy. Soc. Victoria, vol. i., pt. 1), should be replaced by *Megascolides*, M'Coy.

Cryptodrilus, Fletch.

Perissogaster, Fletch.

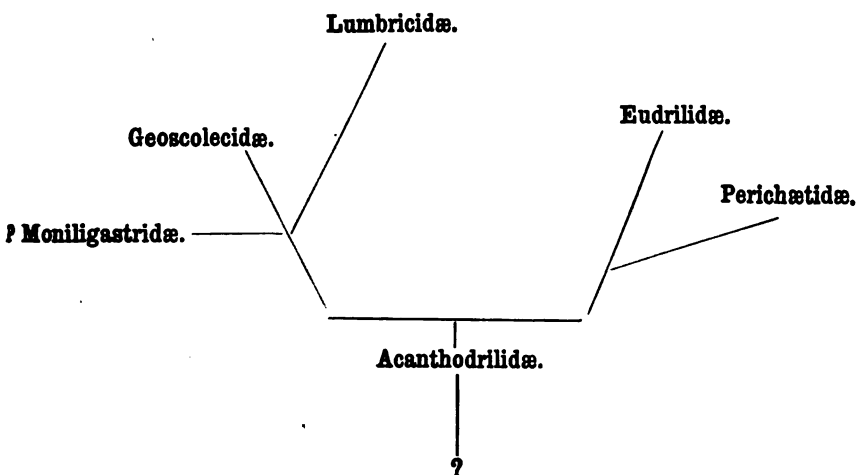
Perichætidæ.

Megascolex, Templ.

Perichæta, Schm.

Perionyx, E. P.

The classificatory scheme is completed on page 19 by a phylogenetic diagram, which is constructed thus:—



I now propose to examine this scheme in detail, and to give my reasons for objecting to parts of it.

Rosa first of all gives his reasons for regarding *all* earthworms as referable to a single group, Terricolæ, equivalent *not* to a group, Limicolæ, but to *each* of various divisions into which the Limicolæ may be divided, such as Enchytræidæ, Tubificidæ. Dr Rosa does not commit himself, and there is no necessity for his doing so, to the precise definition of these groups. Vejdovsky, on the other hand, regards his families of earthworms, such as Pontodrilidæ, Perichætidæ, as equivalent to families of Limicolæ, such as Phreoryctidæ, Tubificidæ, etc. There is thus an important difference, duly emphasised by Rosa, between his scheme and that of Vejdovsky.

The position that I myself take up in this particular matter is one intermediate between that of the two naturalists. I do not consider it possible to retain a group Terricolæ. I consider that earthworms fall into two groups—(1.) Lumbrici; (2.) Moniligastræ—each of which is equivalent to any *one* of the various divisions, such as those enumerated above, into which the aquatic Oligochæta fall. I do not, however, for the present attempt to define what these groups are.

I define the two groups of Lumbrici and Moniligastræ as follows, my definition of Lumbrici being practically that which Rosa applies to the Terricolæ:—

OLIGOCHÆTA.

BRANCH A. Lumbrici.

- (1.) *Two pairs of testes in segments x. and xi. ;¹ sometimes one is wanting.*
- (2.) *One to four pairs of sperm sacs, subdivided into numerous chambers, variously interconnected, sometimes involving the testes and vas deferens funnels.*
- (3.) *Vasa deferentia opening into the segments which contain the testes; generally two (if one pair of testes, then one) on each side, free until their termination or partially fused.*
- (4.) *One pair of ovaries, generally in segment xiii.²*

¹ Rosa calls attention to the anomaly in the position of the testes, etc., in *Microchæta*, as recorded by Benham (Studies on Earthworms, No. 1—Q. J. M. S., vol. xxvi., p. 278 *et seq.*). On examining a specimen of this worm (much softened by imperfect preservation) it appeared to me that the funnels of the vasa deferentia were in segments x. and xi. respectively, and not in ix. and x.; and that my original description (On the Anatomy and Systematic Position of a Gigantic Earthworm, etc.—Trans. Zool. Soc., vol. xii., pt. 3) was so far correct. On the other hand, I have satisfied myself that the vasa deferentia open on to the exterior in segment xix., as Benham stated, and *not* on segment xviii., as I stated. Probably, therefore, though I can make no positive statement, the testes are also in x. and xi.

Rosa fixes the position of the testes “contro alla parete anteriore” as distinctive. I have, however, shown that in *Acanthodrilus annectens* they are attached to *hind* wall of segment (*see* On the Anatomy of Three New Species of Earthworms, etc.—Q. J. M. S., vol. xxx.).

² One or two exceptions to this statement have been recorded. In *Plutellus* (PERRIER, Étude sur un genre nouveau des Lombriciens (*Plutellus*, E. P.)—

- (5.) One pair of oviducts opening internally into the xiiith, externally on to the xivth segment.
- (6.) One pair (rarely two, as in *Perichæta aspergillum*) of egg sacs, minute bodies in segment xiv.

BRANCH B. *Moniligastres*.

- (1.) One pair of testes in ix. or x.
- (2.) One pair of sperm sacs in segment x., with simple undivided cavity.
- (3.) *Vasa deferentia*, one pair opening into ixth or xth segment (according to position of testes) internally, and on to intersegmental groove between x.-xi. externally, by an atrium like that of the *Lumbriculidæ*.
- (4.) One pair of ovaries in segment xi. (?).
- (5.) One pair of oviducts opening behind the atrial pores into segment xi.
- (6.) Egg sacs large, extending through several segments.

It seems to me impossible to regard these two groups as resembling each other so much more closely than either of them resembles any given group of the "*Limicolæ*" as to necessitate their inclusion in the same group. I do not, however, think it worth while to recapitulate more fully than in the above table my reasons for this belief, as I have already discussed the matter in the papers referred to in the footnote.¹

Arch. de Zool. Exp., t. i., 1872), the ducts have been stated to open on to the xth segment.

In *Brachydrius* Benham has stated (Note on a New Earthworm—Zool. Anz., Bd. xi., No. 271) that the ovaries lie in segment xii.—"an unusual position." It is, if no more, a curious coincidence that this should agree exactly with the position of the ovaries in *Microchæta Rappii*, as determined by Benham (Studies on Earthworms, No. 1—Q. J. M. S., vol. xxvi., p. 279) and myself (On the Anatomy and Systematic Position of a Gigantic Earthworm [*Microchæta Rappii*] from the Cape Colony—Trans. Zool. Soc., vol. xii., p. 75), seeing that these genera are allied in other particulars. It is true that both Benham and I myself gave xiii. as the ovarian segment. I myself, however, pointed out later (Descriptions of some new or little known Earthworms, etc.—P. Z. S., 1886, p. 306) that the organ described by us as "ovary" was probably "receptaculum ovarum"—the ovary really lying in segment xii. I have again looked into the matter, and can confirm the above statements with regard to position of ovaries, etc.

¹ For fuller details respecting *Moniligaster*, see my paper On the Structure of a Genus of Oligochæta belonging to the Limicoline Section—Trans. Roy. Soc. Edin., vol. xxxv., and the literature therein cited.

With regard to the subdivisions of the Lumbrici, it is clearly necessary to indicate in the arrangement their probable phylogenetic relationships. This is not indicated by Rosa in his scheme of classification, although he does do so later in his paper in the "Stammbaum," which I have copied into the present communication.

Rosa's classification will doubtless commend itself to many for the reason that it is based upon the total of a large number of characters. If we exclude those which are found in more than one family, we get the following diagnoses of Rosa's families :—

Lumbricidæ—

Male pores in front of clitellum. Gizzard behind sexual organs.

Geoscolecidæ—

Copulatory setæ longer than the others, and of a different form.

Acanthodrilidæ—

Four groups of penial setæ (connected with the four atria).

Eudrilidæ—?

Perichætidæ—

Setæ very numerous in each segment.

All of these families cannot, as constituted by Rosa, be diagnosed at all. Further research, particularly the discovery of the genus *Deinodrilus* and the species *Perichæta stuarti*, has rendered it at least difficult to distinguish the Perichætidæ and the Acanthodrilidæ.

On the other hand, the Lumbricidæ and Geoscolecidæ appear, so far as we know at present, to be natural families. It is, in fact, necessary, in order to arrive at a tabular expression of the real affinities, to combine some of the groups into larger ones, and to split up others into smaller ones. This is, to a certain extent, done by Rosa in his "Stammbaum."

He places the Acanthodrilidæ quite apart from the others, and at the base of the series.

How far is this justified by our present fuller knowledge of this group and of others?

Rosa's reasons for regarding the Acanthodrilidæ as the most primitive existing forms are the following:—

- (1.) The frequent doubling of the dorsal vessel,¹ which seems, from the observations of Kowalevsky and Vejdovsky, to be a persistent embryonic trait.
- (2.) The presence in *A. dissimilis*² of two pairs of ovaries corresponding to the two pairs of testes.
- (3.) The comparative independence of the two vasa deferentia of each side.
- (4.) (This is queried) the presence of 8 nephridia per somite in *A. multiporus*.

As regards (1.) it is undoubtedly true that a good number of species of *Acanthodrilus* (four or five) show the peculiarity mentioned. But this same doubling of the dorsal vessel occurs in *Megascolex cæruleus*³ and in *Microchaeta Rappii*,⁴ in *Deinodrilus Benhami*⁵ and in *Teleudrilus Ragazzii*.⁶ It is, however, more frequent in the Acanthodrilidæ than in other families.

(2.) The rudiment of a second ovary (in segment xii.) seems, from the researches of Bergh,⁷ to be so often met with in *Lumbricus*, that I am not disposed to lay much stress upon this character as indicative of the low position of *Acanthodrilus*. Furthermore, I have shown some reasons for thinking that *two* fully developed ovaries are distinctive of *Eudrilus*.⁸

¹ BEDDARD, On the Specific Characters and Structure of certain New Zealand Earthworms—P. Z. S., 1885, p. 821.

² *Ibid.*, p. 828.

³ BEDDARD, On the Anatomy and Histology of *Pleurochaeta Mossleyi*—Trans. Roy. Soc. Edin., vol. xxx., p. 481.

⁴ BEDDARD, On the Anatomy and Systematic Position of a Gigantic Earthworm from the Cape Colony—Trans. Zool. Soc., vol. xii., p. 70; and BENHAM, Studies in Earthworms, No. I.—Q. J. M. S., vol. xxvi.

⁵ BEDDARD, On Three New Species of Earthworms, etc.—Q. J. M. S., vol. xxx.

⁶ ROSA, Lombrichi delle Scioa—Ann. Mus. Civ. Geneva, ser. 2, vol. vi. (1888), pl. ix, fig. 2.

⁷ Geschlechtsorgane der Regenwürmer—Z. wiss. Zool., Bd. xlv., pl. xxi., fig. 10, s.

⁸ Further Notes upon the Reproductive Organs of *Eudrilus*—Zool. Anz., No. 293 (1888).

(3.) As to the vasa deferentia, it remains to be seen whether there are not two distinct pairs in Bourne's *Perichæta Stuarti*.¹ There are certainly in *Eudrilus*.²

(4.) We next come to the nephridia. Rosa, in the course of his remarks, supports my view as to the archaic nature of the excretory system of *A. multiporus*, though evidently with some doubt, as is evinced by the query which precedes his remarks. He concludes these in the following words:—
 “Tuttavia bisogna notare que egli considera come ancora più primitiva la disposizione che si ha nell' *A. multiporus* alla parte anteriore del corpo, in cui gli otto canali dei nefridii si ramificano formando un ciclo di pori attorno ad ogni segmento. Il Beddard ritiene che ognuno di questi pori corrispondesse originariamente ad una setola, e perciò che forme primitive avessero un ciclo completo di setole. Ma in tale ipotesi è difficile comprendere come una simile disposizione non si sia trovata in nessuno dei molti Perichetidi che ci son noti.”

The suggestion which Rosa quotes in the above passage has been to a large extent confirmed by my discovery of the relations of the nephridia in *Perichæta*.³

Deferring for a time the question of the nephridia, it does not seem to me that Rosa's views as to the primitive nature of the Acanthodrilidæ can be regarded as established. They are not so convincing to me as are reasons which will be put forward later for placing *Perichæta* in the position occupied by *Acanthodrilus* in Rosa's scheme.

Turning now to the mutual relationships of the remaining families, we find that Rosa unites the Eudrilidæ and Perichætidæ into one group, and the Geoscolecidæ and Lumbricidæ into another; the Moniligastridæ are doubtfully referred to the latter.

The connection is presumably not regarded as a very close one, seeing that there is no indication of it in the classification on pp. 8-10.

¹ Preliminary Notice of Earthworms from the Nilgiris and Shevaroy—P. Z. S. (1886).

² BEDDARD, Contributions to the Anatomy of Earthworms, etc.—P. Z. S. (1887), p. 372.

³ On the Presence of Numerous Nephridia, etc.—Q. J. M. S., vol. xxviii.

The first group (that of the Eudrilidæ and Perichætidæ) are affined by the possession of a complete clitellum¹ of a comparatively constant position; the male apertures are either on the 17th or 18th segment, on the hinder part of the clitellum, or upon one of the immediately succeeding segments; the presence of prostates;² the presumed absence of typhlosole. The last statement is the only one with which I wish to find fault as being inaccurate, though I desire to point out that Dr Rosa could not be aware of its inaccuracy. As a matter of fact I have found a typhlosole in some species of *Perichæta*; for example, in *P. indica* and *P. affinis*.³ It is true that in these species the typhlosole is small; but it is not less developed than in such *Acanthodrilis* as *A. Nova Zelandiæ*.

The second group (including the Lumbricidæ, Geoscolecidæ, and ? Moniligastridæ) presents the following characters:—A saddle-shaped (incomplete) clitellum, of very variable position and extent; male apertures inconstant in position but always in front of the clitellum, or on the anterior region of the clitellum; no prostates; very general presence of a typhlosole, and (I suppose I may add) absence of penial setæ; presence of only 8 setæ in each segment.

These groups are indeed, as Rosa admits, rather different. The *Acanthodrilis*, he thinks, serve to connect them. I append a literal translation of Rosa's view as to this relationship:—"The Acanthodrilidæ have the male pores on the posterior margin of the clitellum, or beyond it; and the clitellum is constituted by a complete girdle, an arrangement which leads to the first group, Eudrilidæ and Perichætidæ. At other times they have the male pores in the median region, or

¹ A "complete" clitellum signifies one in which the glandular substance is developed equally all round the body, instead of only upon the dorsal and lateral regions. As will be seen later (p. 262, footnote), there are reasons, in my opinion, against making any such use of the clitellum in classification.

² I prefer to term these structures "atria," in order to fix their identity with the atria in many of the aquatic genera (Cf. BEDDARD, On the Structure of Three New Species of Earthworms, etc.—Q. J. M. S., vol. xxix., pt. 2, pp. 117-128.

³ Contributions to the Anatomy of Earthworms, etc.—Q. J. M. S., vol. xxx., p. 473.

even anterior region, of the clitellum, which is then ventrally incomplete, as, *e.g.*, in *Trigaster Lankesteri*. This arrangement leads to the Geoscolecidae and Lumbricidae.

"The Moniligastridae can, I think, be regarded as modified Geoscolecidae. The passage between the Geoscolecidae and the Lumbricidae is effected by *Criodrilus*, in which the male pores are immediately in front of the clitellum (Benham). According to this way of looking at the matter, the least modified forms of the Perichætidæ will be sought for in *Megascolex*—that is to say, in those Perichætidæ in which the clitellum is not limited to three segments, and in which the setæ still show median intervals. In these forms there are no lateral intestinal cœca, and the nephridia have still the normal form, as I have seen in *Megascolex (Perichæta) armatus*, Beddard.

"Now it is precisely in *Megascolex* (as thus defined) that bundles of penial setæ are still found, which are wanting in other forms. These are found in *M. armatus*, where they exist in relation to the male pores, and in *Megascolex (Perichæta) ceylonicus*, Beddard: the latter species would appear, according to Beddard,¹ to possess in front of the usual apertures, two others which lead into a blind tube, which may be regarded as a vestige of the first pair of male openings in the Acanthodrilidae."

There is an obvious discrepancy here with views expressed on an earlier page. If it be admitted that one of the reasons for regarding the Acanthodrilidae as the primitive group is the presence of numerous nephridia per somite in *A. multiporus*, it can hardly be said that *Megascolex* (as defined by Rosa) comes nearest to the primitive form *because* it has normal nephridia—that is, one pair per somite! Apparently, however, Dr Rosa was of opinion that the minute nephridia of *Perichæta* (s. str.) were in a degenerate condition, though he quoted (p. 19) Benham's paper, "Studies on Earthworms, pt. i.—Q. J. M. S., vol. xxvi.," in which work Benham refers (at p. 256) to his own and my observations upon *Perichæta*.

¹ Notes on some Earthworms from Ceylon and the Philippine Islands, including a description of two new species—Ann. and Mag. Nat. Hist., ser. 5, vol. 17 (1886), p. 89.

It appears to me, in fact, that the key to the classification of the group is to be found in the modifications of the excretory system.

It is obvious that the way in which any group should be classified is that which will indicate its course of development. Clearly, therefore, characters should be chosen which have a relation to lower forms from which the group to be classified has been evolved. Characters peculiar to the group, however much or appropriately they may vary, can only be regarded as of secondary importance. Where, however, it is a question of indicating the affinity of particular species and genera, then characters peculiar to the group are available. Hence it may be perfectly reasonable to sketch the main outlines of a scheme of classification by the modifications of only a single character; and perfectly unreasonable to do so by the use of even a large number of other characters.

It is a common mistake to think that several characters are necessarily better than one.

Now it appears to me that structures like the clitellum, the setæ, the gizzard, and so forth, are so distinctively "Oligochætous," that it is dangerous to *commence* the broad outlines of a classification by using them as diagnostic characters. It seems to me quite conceivable that these characters and others like them may have changed about so greatly during the course of the evolution of the group as to have several times (independently) produced the same result. I do not think, for example, that the Lumbricidæ and Geoscolicidæ are *necessarily* related on account of the *absence* in both of atria and penial setæ, and in the saddle-shaped clitellum. Such a modification may have occurred more than once.

The nephridia, however, are not distinctively Oligochætous structures even in the actual form which they assume in that group.

As long as one species of *Acanthodrilus* (*A. multiporus*)¹ was the only form known with numerous nephridia per segment, it was perfectly legitimate for Eisig to refuse² to admit this arrangement as the archaic one. It might readily be supposed, as the Naples zoologist supposed, that the multiplication and interconnection

¹ BEDDARD, Preliminary Note on the Nephridia of a new Species of Earthworm—Proc. Roy. Soc., June 1885.

² Die Capitelliden in Fauna und Flora des Golfes von Neapel.

was the result of the division of an originally single pair of nephridia to each segment. Now, however, numerous genera, including most of those with the largest number of species, have been shown by myself,¹ by Benham,² and by Spencer,³ to possess an excretory system of the same kind. These genera include representatives of three out of six of Rosa's families. As both conditions may occur in the same genera (for example *Acanthodrilus*, *Cryptodrilus*, *Perichæta* [*sensu lato*]), it seems clear that one of the two conditions has been several times independently produced.⁴ Thus, after all, it may perhaps be said that Eisig's objections are so far not removed, as there is a simple multiplication of instances. As a question of mere probability it seems to me easier to suppose a reduction than a multiplication of nephridia in a segment, especially as there is at the same time in some genera (in *Perichæta* and *Megascolides* at any rate) a connection between the nephridia not only of the same segment, but also from segment to segment. In these forms, moreover, there is no regularity in the position of the external pores or the cœlomic funnels; they cannot with any approximation to the truth be called "segmental organs." On *a priori* grounds, therefore, the existence of dysmetameric organs in so regularly metameric an animal as an Annelid suggest an inheritance rather than a modification within the group. Another argument for considering the dysmetameric condition as the more primitive is afforded by the genera *Megascolides* and *Acanthodrilus*. In the former genus Spencer⁵ has described nephridia opening by numerous ducts into the pharynx; in *A. multiporus* I have myself found⁶ that the hinder region of the intestine is furnished with numerous diverticula, which become continuous with tubes indistinguishable from the ordinary nephridia. Now it is more

¹ Preliminary Note on the Nephridia of *Perichæta*—Proc. Roy. Soc., vol. xliii, p. 309. The Nephridia of Earthworms—Nature, vol. xxxviii, p. 221 (1887). On the Presence of Numerous Nephridia, etc.—Q. J. M. S., vol. xxviii, p. 397. On certain Points in the Structure of *Urochæta*, etc.—*Ibid.*, vol. xxix, p. 235. On the Structure of Three New Species of Earthworms, etc.—*Ibid.*, vol. xxix, p. 101.

² Studies in Earthworms, No. I.—Q. J. M. S., vol. xxvi, p. 213.

³ The Nephridia of Earthworms—Nature, vol. xxxviii, p. 221; The Anatomy of *Megascolides australis*—Trans. Roy. Soc. Vict., vol. i, No. 1.

⁴ The following have or may have "diffuse" nephridia:—*Perichæta* (and its subdivisions), *Cryptodrilus*, *Megascolides*, *Digaster*, *Didymogaster*, *Dichogaster*, *Acanthodrilus*, *Trigaster*, *Typhæus*, *Deodrilus*, *Deinodrilus*. They include one-half of the known species. There are 19 genera in which the nephridia are always paired.

⁵ *Loc. cit.*, pl. iii, fig. 10.

⁶ On the possible Origin of the Malpighian Tubules in Arthropods—Ann. and Mag. Nat. Hist., 1889, p. 290.

than probable that the anterior and posterior gut regions into which these nephridia open are stomodæum and proctodæum respectively, *i.e.*, epidermic involutions. Hence the existence of numerous nephridial pores may be regarded as having been established before the involution of epiblast to form the two extremities of the digestive tract. A secondary connection seems more unlikely.

It seems therefore permissible to regard these facts as strengthening the justice of the view that the diffuse or dysmetameric nephridia are the most ancient form of these organs; and, if so, they show a decided resemblance to the excretory system of the Planarians, some of which worms appear to me to represent, more nearly than any other living group, the ancestors of the Oligochæta.

This being so, I would associate together all those earthworms which have a nephridial system built upon the Platyhelminth type into one group, on the assumption that the character in which they agree must be a mark of affinity.

This group will include three of Rosa's families, *viz.* :—Perichætidae, Acanthodrilidæ, and Eudrilidæ; and I term it—

Group I. ACANTHODRILINI.¹

Definition.—*Earthworms generally with a diffuse (dysmetameric) nephridial system; always provided with atria which are either tubular or lobate; often provided with penial setæ. Clitellum commencing in the xiiith or xiiiith segment, and of variable extent. Male generative pores on xviiith or xviiiith segment. Spermathecae always (?) furnished with diverticula.*

This group is divisible into the following families :—

1. Family Perichætidae.

Definition.—*Earthworms with numerous setæ per segment arranged in a continuous ring, sometimes with dorsal and ventral gaps, 20 to 100 in number. Nephridia nearly always diffuse. Atria lobate or (rarely) tubular; penial setæ generally absent.*

¹ Exception may be taken to this name, particularly as I regard the Perichætidae as the typical family. I adopt it, however, for the reason that the diffuse nephridia were first made known in *Acanthodrilus*, and that the name may be taken to express the fact that the majority of its members have penial setæ. This led Perrier to apply the name *Acanthodrilus* to the genus.

Genera—*Perichæta* (including *Megascolex* as a sub-genus); *Perionyx*, E. P.; *Diporochæta*, F. E. B.; *Anisochæta*, F. E. B.; *Hoplochæta*, F. E. B.¹

2. Family Cryptodrilidæ.

Setæ 8 in number per segment, paired or distant. *Nephridia* diffuse or paired—if paired, symmetrical or alternate. *Atria* tubular or lobate; *penial setæ* present or absent.

Genera—*Cryptodrilus*, Fletcher; *Megascolides*, M'Coy; *Digaster*, E. P.; *Didymogaster*, Fletch.; *Dichogaster*, F. E. B.; *Plutellus*, E. P.; *Perissogaster*, Fletch.; *Microscolex*, Rosa; *Photodrilus*, Giard; *Pontodrilus*, E. P.; *Rhododrilus*, F. E. B.; *Pygmæodrilus*, Mich.; *Eudriloides*, Mich.; *Callidrilus*, Mich.

3. Family Deinodrilidæ.

Setæ 12 in number per segment. *Clitellum* occupying three segments (xiv.-xvi.); *atria* two pairs of tubular glands opening on to xvii. and xix.; *male generative pores* on xviii. *Penial setæ* present; *nephridia* diffuse.

Genus—*Deinodrilus*.

4. Family Acanthodrilidæ.

Setæ 8 in number per segment, paired or distant. *Clitellum* occupying 4 to 7 segments, xii. (xiii.)-xviii. (xix.); *atria* and *vasa deferentia* as in *Deinodrilidæ*. *Penial setæ* usually present; *nephridia* diffuse or paired—if paired, regular or alternate.

Genera—*Acanthodrilus*,² *Trigaster*. (*Clitellum* exceptionally extended.)

¹ These genera, which are very different from those into which the family is usually divided, are defined in my paper (Observations upon an American Species of *Perichæta*, and upon some other Members of the Genus—P. Z. S., 1890, pt. ii.) upon this family. Vaillant (Histoire des Annelés, etc., p. 63) divides *Perichæta* into no less than eight sub-genera, but on the variations of characters, which I do not agree with him in regarding as very important. Among these are Kinberg's five genera—*Nitocris*, *Amyntas*, *Pheretima*, *Lampito*, and *Rhodopis*, which I had hoped had been finally laid to rest.

² Michaelsen (Oligochæten des naturhistorischen Museums in Hamburg 1, JB. Hamb. wiss. Anst., vi., 1889) has proposed to separate as a distinct genus *Benhamia* those Acanthodrili with more than one gizzard with diffuse nephridia and an "incomplete" clitellum extending beyond male pores. It will include *Trigaster*. In a later paper (Beschreibung der von Herrn Dr F. Stuhlmann im Mündungsgebiet des Sambesi, etc., id., Bd. vii., 1890) this

Observations.—Apart altogether from the nephridia, it is necessary to include these families in one group: they are in every case so closely connected. The more typical *Perichætidæ* seem sharply marked off from any others, but *Deinodrillus* is an almost exactly intermediate form between *Perichæta* and *Acanthodrillus*. It has more than eight setæ in each segment, and a clitellum like that of *Perichæta*. The male reproductive apparatus is like that of *Acanthodrillus*, but in *P. stuarti* of Bourne¹—a form which I have ventured to distinguish generically—we have also *four tubular atria*. Moreover, in *Perichæta ceylonica*,² there are indications of an approach to *Acanthodrillus*, though that species requires further investigation.

With regard to the *Cryptodrilidæ*,³ such a form as *Pontodrillus* is very distinct from *Perichæta*, and in the absence of any knowledge of intermediate forms would have to be separated into a very distinct family. This has been done by Vejdovsky;⁴ but, at the time when he wrote, the two genera *Microscolex* and *Photodrillus*, as well as the Australian genera described by Fletcher,⁵ were unknown. These form collectively a family, which is chiefly defined, however, by negative characters. I exclude from this

separation is still adhered to, but the presence of more than one gizzard is dropped out as a part of the definition. It appears to me also necessary to omit the characters of the clitellum as a definition, since in *Acanthodrillus annectens*—a species with *paired* nephridia—the clitellum extends beyond segment xix. It may be useful, however, to adopt Dr Michaelsen's separation of *Acanthodrili* with diffuse nephridia into a distinct genus, as the genus is even now getting inconveniently large.

¹ Preliminary Notes on Indian Earthworms—pt. i. : On Earthworms from the Shevaroyes and Nilgiris (Proc. Zool. Soc., 1886).

² Notes on some Earthworms from Ceylon and the Philippine Islands, including a description of two new species—Ann. and Mag. Nat. Hist., 1886, p. 89.

³ I name this family *Cryptodrilidæ*, though on the grounds of priority it ought to be called *Megascolididæ*; after the recent discussion in *Nature* (Feb. 13, 1890) about the correct writing of terms borrowed from the Greek, I have not the courage to introduce so awkward a term, and therefore fall back upon *Cryptodrilidæ*. This word has the advantage of being pronounceable, and in calling attention to the fact that *Cryptodrillus* is the most prominent genus of the family.

⁴ *Loc. cit.* (on p. 238).

⁵ Notes on Australian Earthworms—Proc. Linn. Soc. N.S.W., 1886-88.

family *Eudrilus* and *Teleudrilus*, about which something will be said presently. This family is, however, closely connected with the Perichætidæ, through the remarkable genus *Anisochæta* made known by Fletcher. In this form, which I regard as distinct from *Perichæta*, the setæ of the first few anterior segments are eight in number in each segment; afterwards they increase until the normal "perichæteous" condition is reached. This genus connects the two families in the only direction in which any connection is at all necessary. Apart from the setæ, it is absolutely impossible to draw any line, however slender, between the Cryptodrilidæ and Perichætidæ.

My family Cryptodrilidæ does not include *Eudrilus* and the genus *Teleudrilus*, quite recently described by Rosa,¹ and, as I think, for good reasons.

These two genera are unique among Earthworms (1.) in the structure of the female efferent apparatus; (2.) in the structure of the male efferent ducts. There are also a number of smaller points in which they differ from any of the Cryptodrilidæ.

The two vasa deferentia of each side are separate up to their point of opening, a character hitherto confined to the Deinodrilidæ and Acanthodrilidæ (? as to *Hoplochæta Stuarti* and *Megascolex ceylonicus*); they open into the upper end of a structure obviously identical with the atrium of other forms, though differing in many details of structure. In no other case is there a connection between the vasa deferentia and the upper end of atrium, except in *Moniligaster* (which I have already seen reasons for referring to a distinct group, equal to that which includes all other earthworms). These atria are connected with a terminal apparatus of a remarkable nature, which has its nearest analogue in the Tubificidæ.²

¹ Lombrichi dello Scioa—Ann. Mus. Civ. Geneva, ser. 2, vol. vi. (1888), p. 571.

² All these points are more fully treated of in the following papers by myself:—The Reproductive Organs in the genus *Eudrilus*—Proc. Roy. Soc. Edin., vol. xiii., p. 672; Descriptions of some new or little known Earthworms, etc.—Proc. Zool. Soc., 1886, p. 302; Notes on the Ovaries and Oviducts of *Eudrilus*—Zool. Anz., No. 224, 1886; Contributions to the Anatomy of Earthworms—No. 1: On the Structure of *Eudrilus sylvicola* (Proc. Zool. Soc., 1887, p. 372); Further Notes upon the Reproductive Organs of *Eudrilus*—Zool. Anz., No. 293, 1888.

The female apparatus is unique by reason of the fact that the oviducts are highly muscular tubes, that they are continuous with the ovaries, and that the spermathecæ are diverticula of them. The ova themselves have a somewhat peculiar structure and history.¹

Teleudrilus is less peculiar than *Eudrilus*.

The minor peculiarities to which I have referred are (1.) the presence of peculiar bodies in the epidermis, possibly identical in their nature with certain problematical structures in *Urochaeta*;² (2.) the presence of unpaired calciferous glands, as well as paired ones, lying beneath the œsophagus. It is only by omitting to notice these peculiarities that Rosa has forced this genus into his family Eudrilidæ (=my Cryptodrilidæ minus *Eudrilus* and *Teleudrilus*).

It does not appear to me possible to include these two genera in my group Acanthodrilini at all; they are evidently isolated types, whose affinities at present cannot be regarded as certain.³

In the meantime, pending the discovery of intermediate forms, I put them in a group by themselves, which will be defined as follows:—

Group II. EUDRILINI.

Definition.—*Earthworms with regularly paired nephridia, furnished with atria and a terminal copulatory apparatus of a peculiar nature. Oviducts continuous with the ovaries, and opening generally in common with the spermathecæ.*

¹ On the Structure and Development of the Ovum in an Annelid (*Eudrilus*)—*Jour. Anat. Phys.*, vol. xxii., p. 9.

² PERRIER, *Arch. Zool. Exp.*, t. iii., 1874, p. 331.

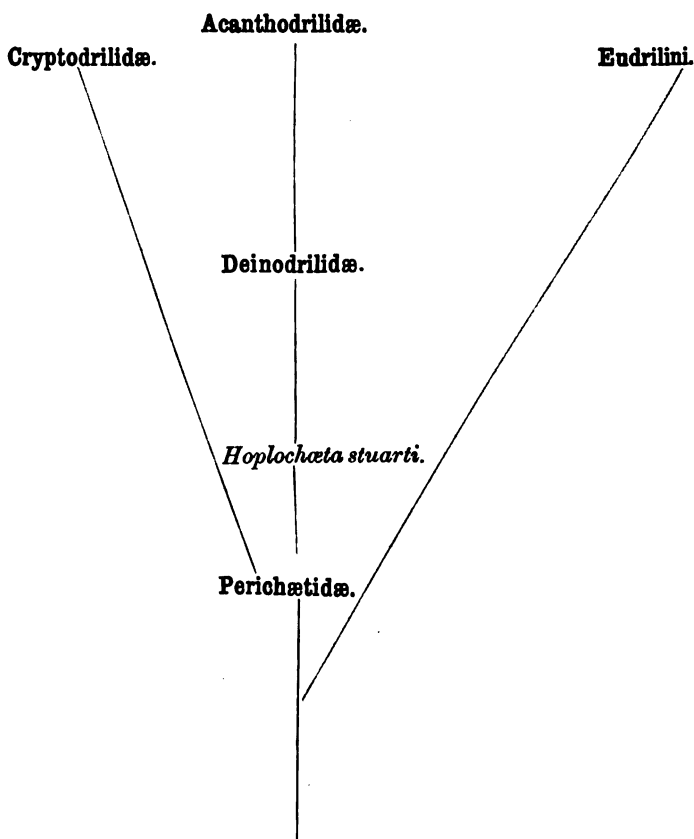
³ Since writing the above I have received Dr Michaelsen's most recent paper, which contains a description of some most interesting forms belonging to this group (*JB. Hamb. wiss. Anst.*, vii.). I have placed the various genera in what I believe to be the proper places in my scheme, but I make no other alterations in the text. I do not regard *Eudriloides* as a link between Eudrilini and Cryptodrilidæ, although its single unpaired spermatheca is in the ovarian segment. This peculiarity is met with among the Geoscolecini.

1. Family Eudrilidæ.¹

Male apertures single or paired on xviith segment. Clitellum occupying segments xiii.-xvii. ; both oviducts and sperm ducts with a muscular coat.

Genera—*Eudrilus*, *Teleudrilus*, *Nemertodrilus*, *Polytorcutus*, *Stuhlmannia*.

The mutual relationships of the Acanthodrilini are, I think, fairly clear from what has been seen on the last page. I should regard the following scheme as indicative of their affinities :—



¹ These definitions can, of course, only be regarded as a preliminary attempt. I make no serious effort to decide which are *probably* of family value and which distinguish the group.

I include the Eudrilini in this table, deriving them from a very primitive stock, of which, however, I consider that they are greatly modified members. I do this chiefly on account of the reproductive organs, which show resemblances to those of Leeches and Platyhelminths.

I regard the Perichætidæ as the most archaic family, not wholly on account of the nephridial system, for in *Megascolides* at any rate, if not in other Cryptodrilidæ, the nephridial system is nearly equally archaic. But it will be noticed, from a consideration of the facts of the case, that the connection between the different forms is rather easier if we derive all from *Perichæta*. Moreover, the complete circle of setæ of *Perichæta*, as well as their wide distribution, is a point to be urged in favour of their archaic nature. These matters are more fully discussed in a paper communicated to the Zoological Society of London in January of this year.

We now come to the more difficult task of classifying the remaining earthworms. It is more difficult, because fewer forms are known, and many of these are very imperfectly known, *e.g.*, *Anteus* and *Geoscolex*.

We may clear the ground by at once admitting the naturalness of the family Lumbricidæ, which, as Rosa says, is generally accepted. I should have regarded them, not as a family equivalent to, for example, the Cryptodrilidæ, but as a group corresponding to that of the Acanthodrilini.

Group III. LUMBRICINI.

Definition.—*Earthworms with a paired series of nephridia never furnished with atria or penial setæ. The setæ on clitellum differing from the others by their greater length. Clitellum commencing not earlier than the 22d segment, and occupying 7-10 segments. Male pores upon segment 12, 13, or 15. Gizzard at commencement of intestine; setæ 8 in each segment, f-shaped and not ornamented.*

Family Lumbricidæ.

(With the characters of the group.)

Genera—*Lumbricus*, L.; *Allolobophora*, Eis.; *Allurus*, Eis.; *Tetragonurus*, Eis.

Observation.—I am doubtful at present about *Criodrilus*. The structure of this worm has been investigated by Vejdovsky,¹ Rosa,² Oerley,³ Benham,⁴ and Collin.⁵

Is Rosa's group of the Geoscolecidae a natural one? It is thus defined by him:—"Male pores within the clitellum between the dorsal and ventral setæ, occupying segments, or intersegmental spaces, very variable in position. Clitellum usually saddle-shaped, varying in length and position. Setæ 8 per segment, disposed in pairs, or distant, or in different arrangements, often varying in the anterior and posterior segments. Copulatory setæ longer than the others, and of a different form. The gizzard (or gizzards) placed anteriorly. Sperm sacs one or two pairs. No prostates or penial setæ."

The following tabular scheme indicates the chief structural points which characterise the ten genera about which alone we have any anatomical knowledge. Rosa refers Kinberg's genera⁶—*Geogenia*, *Tritogenia*, and *Eurydame*, besides Schmarda's⁷ *Pontoscolex*—to this group.

¹ System und Morphologie der Oligochæten. Prag, 1884, *passim*.

² Sul *Criodrilus lacuum* Studio Zoologico ed Anatomico—Mem. R. Acc. Sci. Torino, ser. 2, t. xxxviii. (1887).

³ Morphological and Biological Observations on *Criodrilus lacuum*—Q. J. M. S., vol. xxvii. (1887), p. 551.

⁴ Studies on Earthworms—III. *Criodrilus lacuum*, Hoffmeister (Q. J. M. S., vol. xxvii., 1887, p. 561).

⁵ *Criodrilus lacuum*—Zeitschr. wiss. Zool., Bd. xlv. (1888).

⁶ *Annulata nova*—Öfv. af K. Vet. Akad. Förh. (1866).

⁷ Neue Wirbellose Thiere gesammelt auf einer Reise um die Erde, vol. ii. (1861), p. 11.

	Seta.	Clitellar seta.	Clitellum.	Proctotermium pores.	Male pores.	Testes.	Sperm sac.	Nephridia.	Gizzard.	Calc. glands.	Spermathecae.	Dorsal pores.	Other structures.
<i>Urochaeta</i> .	Paired in front; afterwards irregular; bifid at tip.	Ornamented	16-22; saddle-shaped.	0	19/20	One pair in 11.	One long pair.	Mucous glands opening on 2d, paired nephridia from 4th segment with sphincter.	One in 6.	Three pairs in 6, 7, 8.	Three pairs in 7, 8, 9.	0	....
<i>Microchaeta</i> .	Paired; anterior setae ventral setae modified.	Unornamented.	10-23; or 12-25; saddle-shaped.	+	19	Two pairs in 9, 10, or one pair in 9.	Two pairs in 10, 11, or one in 10.	Anterior set differing in structure from posterior.	One in 6.	One pair in 9, or two in 8, 9.	Several minute pouches in 12, 13, 14, 15, or in 11, 12.	0	Ovaries in 12. (?)
<i>Brachydrilus</i> .	Paired.	Unornamented.	? 16-21.	+	18	Two pairs in 10, 11.	Two pairs in 10, 11.	Two pairs in each segment.	One in 6 or 7.	Two pairs in 8, 9.	Several minute pouches in 11.	0	Ovaries in 12. (?)
<i>Diachaeta</i> .	Irregular from the first.	Unornamented.	20-33; continuous.	0	22	? in 11.	One pair of long sacs.	Mucous gland; paired nephridia.	One in 6.	0.	Three pairs in 6, 7, 8.	0	....
<i>Onychochaeta</i> . ¹	Irregular from the first; very varied in form; three kinds.	Ornamented	?	0	?	Two pairs in 10, 11.	Two pairs of sacs.	Mucous gland; nephridia with sphincter.	One in 6.	One pair.	Three pairs in 6, 7, 8.	0	....
<i>Rhinodrilus</i> .	Setae paired; ornamented.	More marked in their ornamentation.	Saddle-shaped; 20-27, or 15-23, or 19-21.	Long.	19/20, or 26 or 13.	Two pairs in 10, 11.	Two in 12, 13; (?) in 11, 19.	Anterior set of nephridia differ from posterior.	One in 10-12.	Six pairs.	One or three pairs in 6, 7, 8.	0	Penial setae as in <i>Photodrilus</i> occur in <i>Rh. tenkatei</i> .
<i>Urobenus</i> .	Paired.	Slightly different.	Saddle-shaped; 14-26.	+	20	Two pairs in 10, 11.	Two pairs in 12, 13, and 14.	Anterior set of nephridia differ.	One in 8.	Three pairs in 9, 10, 11.	Three pairs in 7, 8, 9.	?	Intestinal coeca as in <i>Perichæta</i> ; posterior glands as in <i>Urochaeta</i> .
<i>Hormogaster</i> .	Dorsal paired; ventral distant.	Slightly different.	Saddle-shaped; 15-25.	+	15/16	Two in 10, 11.	Two pairs in 11, 12.	Paired.	Three in 6, 7, 8.	0	Three pairs in 10, 11, 12.	0	....
<i>Glyphidrilus</i> .	Distant.	?	23-32.	?	27/28	?	?	?	?	?	?	?	....
<i>Geoscolax</i> .	Distant and paired.	?	Saddle-shaped; 14-28.	+	18/19	....	One long pair.	Paired.	Present.	?	?	0	....
<i>Anteus</i> .	Paired.	?	Saddle-shaped; 15-29.	+	?	?	?	Paired.	Present.	?	One pair in 7.	0	....

¹ I describe this form, which I believe to be generically distinct, as a species of *Diachaeta* in a forthcoming number of the "Quarterly Journal of Microscopical Science."

It results from the above table that our knowledge of this group is still very incomplete. There are many gaps which require filling up. There appear to be, however, a number of characters in which *all* the genera agree, many of which have been already mentioned by Rosa. These are as follows:—

- (1.) Paired nephridia.
- (2.) Absence of atria and of penial setæ.¹
- (3.) Spermathecae without diverticula.
- ? (4.) Absence of dorsal pores.
- (5.) Gizzard (or Gizzards) anterior in position.
- (6.) Generative pores within the clitellum.

Considered individually these characters are not, perhaps, very important. There seem to me to be no good reasons why any one of them should not have been independently acquired more than once.

Seeing, however, that they occur in all of a number of genera, which are also interconnected in other ways, it is, in my opinion, necessary for the present to retain this group, which I term

Group IV. GEOSCOLECINI.

Definition.—*Earthworms with paired nephridia; never furnished with atria or penial setæ (? Rhinodrilus). Clitellar setæ often modified; spermathecae without diverticula. No dorsal pores. Gizzard (or gizzards) anterior in position. Setæ 8 in each segment, paired or distant, or irregular in their arrangement. Male pores within the clitellum.*

The differences between the genera which make up this

¹ Horst has described (Descriptions of Earthworms, I.—Notes Leyd. Mus., 1887, p. 101) in *Rhinodrilus tenkatei* the remarkable fact that “the ventral setæ of the 17th, 18th, and 19th segments were replaced by a fascicle of four bristles.” This is suggestive of the persistence (and multiplication) of penial setæ, and appears in any case to be a particular point of resemblance to *Photodrilus*, in which worm Giard (Sur un nouveau genre de Lombriciens phosphorescents, etc.—Comptes Rendus, Nov. 7, 1887) has recorded similar structures.

group are so great, that it is requisite to divide it into several families.

1. Family Urochætidæ.

Setæ irregular in distribution either throughout the whole body or after the first 10 segments or so. Prostomium absent. Spermathecae, three pairs. Calciferous glands, three pairs. Nephridia with sphincter.¹ A mucous gland present, being 1st nephridium.

Genera—*Urochæta*, E. P.; *Diachæta*, Benham; *Onychochæta*, F. E. B.

2. Family Geoscolecidæ.

Setæ paired or distant (both conditions occurring in the same species); prostomium present. Nephridia all alike.

Genera—*Geoscolex*, Leuck.; *Hormogaster*, Rosa; ? *Glyphidrilus*,² Horst.

3. Family Rhinodrilidæ.

Setæ paired or distant. Anterior set of nephridia different from posterior.

Genera—*Microchæta*, F. E. B.; *Brachydrilus*, Benham; *Urobenus*, Benham; *Rhinodrilus*, E. P.; ? *Anteus*, E. P.³

I do not regard these families as in any way so satisfactory as those of the Acanthrodrilini.

The Urochætidæ is perhaps the best and most natural. I am quite prepared to admit that the two last might possibly be with advantage broken up still further.

¹ I apply this name to the little muscular cup first described by Perrier, *loc. cit.* (on p. 255), which surrounds the extremity of the muscular sac of the nephridium.

² At present our knowledge of this evidently very interesting form is confined to the briefest of abstracts given in the Procès Verbal of the Dutch Zoological Society (Nederl. Dierh. Ver. Verslag der Vergadering van 26 October 1889, p. 1).

³ I have already pointed out (On the Structure of a new Genus of Lumbricidæ, *Thamnodrilus Gulielmi*—P. Z. S., 1887, p. 154) the resemblances between *Anteus* and *Rhinodrilus*. I should not be at all surprised to learn that they are congeneric.

Rosa regards his family Geoscolecidae (=my group Geoscolecini) as being more nearly related to the Lumbricidae than to any of the other groups. *Criodrilus*, according to him, is the connecting link. The Acanthodrilidae he thinks bring them into relations with other forms. Some Acanthodrilidae have a complete clitellum; these lead to the *Perichætidæ*. In others, as in *Trigaster Lankesteri*, the clitellum is ventrally incomplete; this leads to the Geoscolecidae and Lumbricidae. It seems to me that Rosa lays too much stress upon the form of the clitellum,¹ as of classificatory value; a strict adherence to the principle laid down by him would necessitate the removal of *Diachæta* from the Geoscolecidae; for in this genus, as Benham informs us, the clitellum "completely surrounds the body as in *Perichæta*, *Digaster*, etc."

The entire group Geoscolecini is, in fact, intermediate in its characters between the Acanthodrilini and the Lumbricini, but its relations with the Acanthodrilini are not, I believe, with the family Acanthodrilidae, but rather with the Cryptodrilidae. The satisfactory definition of this group and of the Lumbricini is rendered difficult by the fact of its intermediate character; it shades off at one end into the Cryptodrilidae, and at the other into the Lumbricidae.

One of the characteristic features of the group (which it shares with the Lumbricini) is the modification of the clitellar setæ, and also the fact that these and sometimes the setæ elsewhere are ornamented. Among the Acanthodrilidae nothing of the kind has as yet been described; but among other families of the Acanthodrilini such variations in the

¹ The purely saddle-shaped clitellum of the Lumbricidae (cf. ROSA, I lumbricidi del Piemonte, Torino, 1884, figs. 1, 4, and 5) is so far modified in such Geoscolecidae as *Rhinodrilus* (cf. REDDARD, On the Structure of a new Genus of Lumbricidae, *Thamnodrilus Gulielmi*—P. Z. S., 1887, fig. 1, p. 155, fig. 2, p. 157), that the anterior part has a much narrower ventral gland-free area than the posterior part. The next stage, which is exemplified not only in *Acanthodrilus*, but in such "Eudrilidæ" as *Deodrilus*, shows an entire disappearance of the ventral non-glandular area in front, but a broad non-glandular tract is still left behind. Finally, we have the "complete" clitellum of *Perionyx*, etc. Apart altogether from classificatory difficulties which are involved if the modifications of the clitellum, as used by Rosa, are retained, it is impossible to say where the line is to be drawn. The clitellum of *Urochæta* and *Rhinodrilus* appears to be exactly intermediate between those of *Lumbricus* and *Acanthodrilus*.

form of the setæ are occasionally, although not very commonly, met with. In *Perichæta Houletti* the clitellar setæ are very distinctly different in form from the rest.¹ But the most striking resemblance is shown by *Deodrilus*,² in which all the setæ of the body are ornamented, though in a way rather different from that of *Rhinodrilus* and other Geoscoleline genera. It is remarkable also that among the Cryptodrilidæ only—in the genera *Deodrilus* and *Typhæus*—has the prostomium disappeared:³ this is a character which distinguishes no less than three genera of Geoscolecini—viz., *Urochæta*, *Diachæta*, and *Onychochæta*—and is unknown elsewhere.

If the characters of the clitellum are by any one considered necessary, then *Deodrilus* fulfils the required conditions; for, as I hope to point out later, the clitellum is constructed on a plan which is exactly that of *Acanthodrilus*.⁴ The presence of atria is one of the distinguishing features of the Acanthodrilini, being, without any exception, universal in that group. Is it not possible that the so-called atria of *Criodrilus*⁵ and *Geoscolex*⁶ may represent these same structures in course of degeneration?⁷ Unfortunately we have no histological

¹ BEDDARD, Contributions to the Anatomy of Earthworms—No. III. Note on the Genital Setæ of *Perichæta Houletti* (P. Z. S., 1887, p. 389). The woodcut illustrating those setæ is not so good as it might be.

² A description of this genus, which is a native of Ceylon, will appear in a forthcoming number of the "Quarterly Journal of Microscopical Science."

³ I have not myself been able to find a prostomium in this genus; but I may possibly have failed to see one, since Bourne (On certain Earthworms from Western Himalayas, etc., J. A. S. B., vol. lviii., p. 110) has lately described and figured a prostomium, capable of being largely retracted in a new species of the genus *T. Masoni*.

⁴ *Trigaster Lankesteri* (BENHAM, Studies on Earthworms, No. II.—Q. J. M. S., vol. xxvii.) has been regarded by Rosa as having an incomplete clitellum. Benham is not perfectly precise upon this point in his paper, but he has informed me since, that in front of the generative pores, as in other Acanthodrilidæ, the clitellum is complete.

⁵ ROSA, *loc. cit.* (on p. 258), p. 12, fig. 8, *atr.*

⁶ PERRIER, *Mém. pour servir à l'histoire, etc., loc. cit.* (on p. 236).

⁷ Michaelsen's *Callidrilus* appears also to be a connecting link between the Cryptodrilidæ and Geoscolecini; its general organisation conforms to that of the former group, but it has, as in *Microchæta*, numerous minute spermathecae in segment xiii. This is one of those facts which point to the Geoscolecini being a composite group derived from several stocks.

data with regard to these structures, which seem also to exist in *Brachydrilus*.¹

I have already pointed out that in *Allurus*,² the structure termed atrium by Rosa,³ and therefore in all probability the similarly termed structure in *Allolobophora* is really hardly comparable to the atrium in any Acanthodrilini. It consists merely of a thickening of the body wall, or rather of the epidermis only, at the point of opening of the vasa deferentia, similar in structure to the clitellum. This modification may, however, conceivably be a last trace of an atrium; it remains to be seen what is the structure of that of *Geoscolex*, etc.

All these reasons lead to the inference that the Geoscolecini are connected with the Acanthodrilini, and, as it appears to me, more nearly to the Cryptodrilidæ than to any other family. But the fact that most of the genera of Geoscolecini are much specialised in various directions, renders it difficult to say which are the more centralised forms. No genus, to my mind, can claim to be nearer to the base of the series than any other. As to their connection with the Lumbricini, that appears to be as Rosa has suggested, through *Criodrilus* and *Hormogaster*.⁴ The clitellum of *Glyphidrilus* in its position and extent approaches that of the Lumbricidæ.

I conclude this part of my paper with a recapitulation of the groups and families, and with a "Stammbaum," which

¹ Benham says of this worm (Note on a new Earthworm—Zool. Anz., No. 271, 1888):—"There is no 'prostate' or glandular diverticulum of the distal end of the sperm duct; but on each side is a very large muscular (! glandular also) 'atrium,' as in *Criodrilus* and *Titanus*: this occupies about six somites (xv. to xx.), and is doubtless due, in part at least, to the contracted condition of the worm, causing the dorsal wall of the above-mentioned fossa to project inwards."

² On the Anatomy of *Allurus tetraedrus* (Eisen)—Q. J. M. S., vol. xxviii., p. 365.

³ I lombrichi del Piemonte, Torino, 1884, p. 52. The species of *Allolobophora* in which the presence of an atrium is specially mentioned are *A. profuga*, *A. minima*, *A. subrubicunda*, *A. chlorotica*, *A. mucosa*, *A. turgida*, *A. alpina*, *A. fatida*, in fact nearly all. It is also found in *Lumbricus melibæus* and *L. herculeus*. In later papers its presence is mentioned in other species.

⁴ Rosa, Sulla Struttura dello *Hormogaster Redii*—Mem. R. Acc. Torino, ser. ii., t. xxxix.

seems to me to best express their mutual relationships in the light of our present knowledge.

BRANCH A—*MONILIGASTRES*.

BRANCH B—*LUMBRICI*.

Group I.—*EUDRILINI*.

Fam. Eudrilidæ.

Genera — *Eudrilus*, *Teleudrilus*, *Nemertodrilus*,
Polytoreutus, *Stuhlmannia*.

Group II.—*ACANTHODRILINI*.

Fam. 1. Perichætidæ.

Genera—*Perichæta*, *Megascolex*, *Hoplochæta*, *Anisochæta*, *Aporochæta*, *Perionyx*.

Fam. 2. Deinodrilidæ.

Genus—*Deinodrilus*.

Fam. 3. Acanthodrilidæ.

Genera—*Acanthodrilus*, *Trigaster*, *Benhamia*.

Fam. 4. Cryptodrilidæ.

Genera—*Cryptodrilus*, *Megascolides*, † *Plutellus*, *Digaster*, *Didymogaster*, *Dichogaster*, *Perissogaster*, *Microscolex*, *Photodrilus*, *Pontodrilus*, *Rhododrilus*, *Typhæus*, *Deodrilus*, *Eudriloides*, *Callidrilus*, *Pygmaodrilus*.

Group III.—*GEOSCOLECINI*.

Fam. 1. Urochætidæ.

Genera—*Urochæta*, *Diachæta*, *Onychochæta*.

Fam. 2. Geoscolécidæ.

Genera—*Geoscolex*, *Hormogaster*, † *Glyphidrilus*.

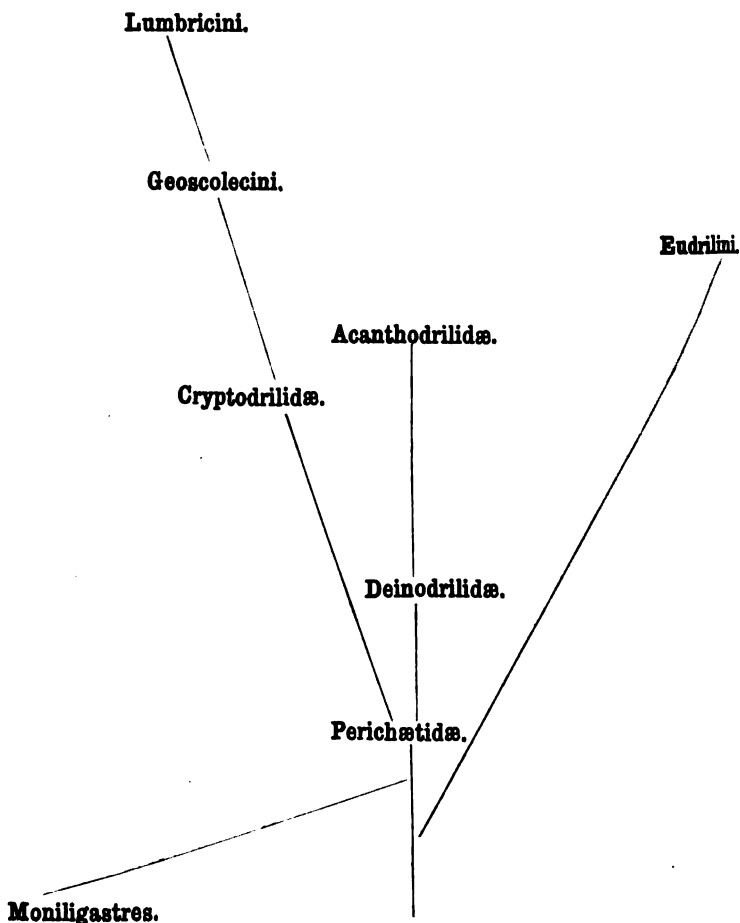
Fam. 3. Rhinodrilidæ.

Genera — *Rhinodrilus*, *Microchæta*, *Brachydrilus*,
Urobenus, † *Anteus*.

Group IV.—*LUMBRICINI*.

Fam. Lumbricidæ.

Genera—*Lumbricus*, *Allolobophora*, *Allurus*, *Tetragonurus*.



PART II.—DISTRIBUTION.

There has been no general account given of the distribution of this group, excepting a short note by Rosa¹ some two years ago. Since that time our knowledge of the group has

¹ Nuova Classificazione dei Terricoli—Boll. Mus. Zool. Torino, vol. iii, 1888, No. 41, pp. 14, 15.

increased to some extent, so that it seems worth while again to collect the available data and to present them in a compact form. The distribution of any group is worth studying as a contribution to the general subject, but the Lumbricidae are of special interest, and for two principal reasons:—In the first place they occur everywhere, and under nearly all conditions. Accordingly, it is possible to test the influence of climate, altitude, and other conditions exerted upon them. In the second place, they are eminently land animals and possess but little power of dispersion across countries which are separated by salt water. The animals themselves are in the highest degree susceptible to salt water and are killed by a very short immersion. Darwin particularly mentions this fact in relation to their occurrence in Argentina and the Falklands.

But in spite of this fact which seems to be almost of general significance, there are here and there exceptions. The most marked exception is the genus *Polydora*. The two species of this genus—*P. littoralis* and *P. lignorum*—live habitually upon the sea-shore and are not killed by the waves, but above the high-water mark they never occur on the southern French coast near Marseilles, and Villefranche.

This being the case, it is surprising that no attention has not been made more use of in writing upon the distribution. Even an excellent work by Heilprin's recently published contains no mention of the subject.

The barriers on land to the distribution of earthworms are not many. They are not killed by cold upon no special kind of soil, and they are not killed by damp. Rivers would not be a barrier to the distribution of species without immersion in fresh water. Deserts, however, would be a barrier to the distribution of earthworms.

¹ The Formation of Vegetative Mounds among Earthworms, 1830, p. 120.

² GARDNER, E., Color and the Distribution of Earthworms, Nature, xii, p. 225.

³ PARRIS, E., Notes on the Distribution of Earthworms, Zool. Exp., t. ix, 1891, p. 225.

earthworm fauna of Africa is very different indeed from that of the warm parts of Europe or of Asia. It seems clear, however, that although special soils are not required for the *existence* of worms, they affect their *numbers* very considerably. Naturally a soil which is rich, and productive of abundant vegetation, will harbour more worms than one which is poor.

It has been noticed by many that cultivation has a great deal to do not only with the abundance but even the presence of worms in the soil at all. Certain districts of North America have been stated to be entirely devoid of earthworms until put under cultivation.

Cultivation of the land has a very marked influence on the abundance of the worms found in it. Mr Fletcher found¹ that in the neighbourhood of Burrawang, N.S.W., the average was 10,000 per acre in virgin soil. Urquhart² gives 348,840 and 784,080 as the average in New Zealand districts which had been seventeen years in grass; and Mr W. W. Smith³ gives an estimate for cultivated lands of 5-16 per square foot.

Before discussing some of the inferences which may be drawn from a study of the distribution of this group of worms, it is requisite to lay before the reader the facts.

I shall only mention those species which have been identified in a trustworthy manner, indicating others with a mark of interrogation. The regions introduced by Mr Sclater will be adopted, the precise habitat of the species being also given, so far as is possible. Those which also occur in other regions have the initial letter of that region appended, and are printed in Clarendon type. In the case of genera occurring in more than one region the generic name only is thus distinguished, and only once for each region.⁴

¹ Notes on Australian Earthworms—Proc. Linn. Soc. N.S.W. (1886), p. 527.

² On the Habits of Earthworms in New Zealand—Trans. N.Z. Inst., vol. xvi. (1883), p. 269.

³ Notes on New Zealand Earthworms—Trans. N.Z. Inst., vol. xix. (1886), p. 133.

⁴ In the tables of species the term *Perichæta* is applied to all those species which are included in the subgenera *Perichæta* and *Megascolex* as defined by myself (P. Z. S., 1890, pt. ii.). This is done for the sake of uniformity. It would be impossible to apply the terms accurately in some cases.

I. Neotropical Region, N.

1. *Geoscolex maximus*, Leuck. (= *Titanus brasiliensis*, E. P.).
Brazil.
2. *Geoscolex Forguesi*, E. P. La Plata.
3. *Anteus gigas*, E. P. Cayenne.
4. *Rhinodrilus paradoxus*, E. P. Venezuela. O.
5. *Rhinodrilus* (*Thamnodrilus*) *Gulielmi*, F. E. B. British
Guiana.¹
6. *Rhinodrilus tenkatei*, Horst. Surinam.
7. *Urochæta corethrura* (Fritz Müller). Brazil, Martinique,
Bermuda. O., A.
8. *Acanthodrilus georgianus*, Mich. S. Georgia, Falklands.
N', E., A.
9. *Acanthodrilus pictus*, Mich. Valdivia, Chili.
10. *Acanthodrilus Hilgeri*, Mich. Corral, Chili.
11. *Acanthodrilus littoralis* (Kinberg) (= *A patagonica*, Kinb.).
Straits of Magellan.
12. *Acanthodrilus Bovei*, Rosa. Puntarenas.
13. *Acanthodrilus Dalei*, F. E. B. Falklands.
14. *Eudrilus peregrinus*, E. P. (? = *E. Lacazii* and *E. decipiens*).
Rio Janeiro, Martinique, Bahamas. A.
15. *Eudrilus silvicola*, F. E. B. British Guiana.
16. *Perichæta indica*, Horst. O., A.
17. *Perichæta affinis*, Perrier. O.
18. *Perichæta Houletti*, E. P. Bahamas. O.
19. *Perichæta aspergillum*, E. P. Bermuda.
20. *Perichæta elongata*, E. P. Peru.
21. *Perichæta dicystis*, E. P. Brazil.
22. *Perichæta tricystis*, E. P. Brazil.
23. *Diachæta Thomasii*, Benh. St Thomas.
24. *Onychochæta Windlei*, F. E. B. Bermuda.
25. *Urobenus brasiliensis*, Benh. Pedza Açú.
26. *Trigaster Lankesteri*, Benh. St Thomas.
27. *Allolobophora subrubicunda*, Eisen. Puntarenas. P., N'.
28. *Allolobophora trapezoides*, Dugès. Corral, Chili. P.
29. *Allolobophora fœtida*, Sav. Lota, Chili. P., N'.
30. *Allurus tetraedrus*, Sav. Valparaiso. P., N'.
31. *Cryptodrilus*² (?) *spatulifer*, Mich. Corral, Chili. O., A.

¹ This worm really possesses a long retractile prostomium and ornamented setæ, and should therefore be included in genus *Rhinodrilus*.

² The query is that of the describer.

And the following, which need further study, and are at present unrecognisable. Those are queried whose generic name is even doubtfully correct :—

- † *Pontoscolex arenicola*, Schmarda. Jamaica.
- † *Eurydame insignis*, Kinberg. St Joseph, Panama.
- Nitocris* (= *Perichæta*) *gracilis*, Kinberg. Rio Janeiro.
- † *Hypogæon atys*, Kinb. Buenos Ayres.
- † *Hypogæon heterostichon*, Schmarda. Quito.
- † *Lumbricus armatus*, Kinb. Buenos Ayres.
- † *Lumbricus alyattes*, Kinb. Buenos Ayres.
- † *Lumbricus tellus*, Kinb. Buenos Ayres.
- † *Lumbricus pampicola*, Kinb. Monte Video.
- Mandane* (= *Acanthodrilus*) *stagnalis*, Kinb. Monte Video.
- † *Lumbricus malutinus*, Weyenberg. Argentine.
- † *Lumbricus argentinus*, Weyenb. Argentine.
- † *Lumbricus dissidens*, Weyenb. Argentine.
- † *Lumbricus corduensis*, Weyenb.¹ Argentine.
- † *Lumbricus luteus*, Gay. Chili.
- † *Lumbricus valdiviensis*, Gay. Chili.
- † *Lumbricus semifasciatus*, Burmeister.

II. Nearctic Region, N'.

1. *Acanthodrilus* (*Diplocardia*) *communis*, Garman. Illinois. N., E., A.
2. *Plutellus heteroporus*, E. P. Pennsylvania.
3. *Perichæta* sp. (in hot-houses). N., O., E., A.
4. *Tetragonurus pupa*, Eisen. Canada.
5. *Allurus tetraedrus* (?).² Canada. P., N.

¹ With regard to the species described by Weyenberg (*Descripciones de nuevos gusanos*—Boll. Ac. Rep. Arg., pp. 213-218), it is clear that, whatever they may be, the last two are not *Lumbricus*, since the clitellum occupies in *L. dissidens* segments 15-18, and in *L. Corduensis* 18-22, or 17-21. The former species is said to have no prostomium. The first two species may be *Lumbricus*, but it is impossible to identify any of them.

² *Allurus tetraedrus* must be regarded as a rather uncertain North American form. I have included it in the list on the strength of a specimen kindly sent to me some time since by Mr Tyrrel of the Canadian Geological Survey. I examined this specimen by means of longitudinal sections, and identified it with *Allurus* on account of the structure of the gizzard (see BEDDARD, On the Anatomy of *Allurus tetraedrus*—Quart. Journ. Micr. Sci., vol. xxviii.). But as *Tetragonurus* has not been anatomised, it is far from impossible that that genus may prove to be identical in this particular with *Allurus*. The sexual organs were not sufficiently developed to permit of any certain con-

6. *Allolobophora bæckii*, Eisen. California. P.
7. *Allolobophora chlorotica*, Hoffm. California, P.
8. *Allolobophora fætida*, Sav. Illinois, Iowa. P., N., A.
9. *Allolobophora subrubicunda*, Eisen. Canada. P., N.
10. *Allolobophora mucosa*, Eisen. New England, Illinois. P.
11. *Allolobophora trapezoides*, Dugès. New England, Canada, etc. P.
12. *Allolobophora tenuis*, Eisen. New England, etc. P.
13. *Allolobophora tumida*, Eisen. New England. P.
14. *Allolobophora parva*, Eisen. New England. P.
15. *Lumbricus herculeus*, Sav. New England. P.
16. *Lumbricus rubellus*, Hoffm. Newfoundland. P.
17. *Lumbricus castaneus*, Sav. Canada. P.

The following are not recognisable:—

- Lumbricus americanus*, E. P.
- ? *Lumbricus Apii*, Kinb. California.
- ? *Hypogæon hirtum*, Sav. Philadelphia.
- Pheretima* (= *Perichæta*) *californica*, Kinb. California.

III. Ethiopian Region, E.

1. *Acanthodrilus capensis*, F. E. B. Cape of Good Hope. N., N', A., E.
2. *Acanthodrilus Büttikoferi*, Horst. Liberia.
3. *Acanthodrilus Schlegelii*, Horst. Liberia.
4. *Acanthodrilus Beddardi*, Horst. Liberia.
5. *Acanthodrilus verticillatus*, E. P. Madagascar.
6. *Acanthodrilus scioanus*, Rosa. Let. Marefia, Scioa.
7. *Acanthodrilus Stuhlmanni*, Mich. Zambesi.
8. *Acanthodrilus affinis*, Mich. Zambesi.
9. *Perichæta capensis*, Horst. Cape of Good Hope. N., N', O., E., A.
10. *Perichæta robusta*, E. P. Mauritius.
11. *Teleudrilus Ragazzii*, Rosa. Scioa.
12. *Microchæta Rappii*, F. E. B. Natal.
13. *Microchæta Beddardi*, Benh. Natal.
14. *Pygmæodrilus quilimanensis*, Mich. Zambesi.

clusions, and these are the only organs at present which would enable the question to be decided; the male apertures are on the 12th segment in *Tetragonurus*, on the 13th in *Allurus*.

15. *Eudriloides parvus*, Mich. Zambesi.
16. *Eudriloides gypsatus*, Mich. Zanzibar.
17. *Nemertodrilus griseus*, Mich. Zambesi.
18. *Callidrilus scrobifer*, Mich. Zambesi.
19. *Polytoreutus cæruleus*, Mich. Zanzibar.
20. *Stuhlmannia variabilis*, Mich. Zanzibar.
21. *Perionyx* sp., Mich. Zambesi. O.

The following imperfectly characterised species have been described from this region. The queries signify that the generic name is not certainly correct:—

- ‡ *Geogenia natalensis*, Kinb. Natal.
- Perichæta rodericensis*, Grube. Mauritius.
- Lampito* (= *Perichæta*) *Mauritii*, Kinb. Mauritius.
- Perichæta Sanctæ Helenæ*, Baird. St Helena.
- ‡ *Lumbricus Josephinæ*, Kinb. St Helena.
- ‡ *Lumbricus Eugeniæ*, Kinb. St Helena.
- ‡ *Lumbricus Helenæ*, Kinb. St Helena.
- ‡ *Lumbricus Hortensiæ*, Kinb. St Helena.
- ‡ *Lumbricus infelix*, Kinb. Natal.
- ‡ *Lumbricus capensis*, Kinb. Cape Colony.
- ‡ *Lumbricus rubrofasciata*, Baird. St Helena.
- ‡ *Hegisipyle Hanno*, Kinb. Natal.

IV. Palearctic Region, P.

1. *Microscolex modestus*,¹ Rosa. Italy. Tenerife.
2. *Photodrilus phosphoreus*, Giard. N. France.
3. *Pontodrilus littoralis*, Grube. S. France.
4. *Pontodrilus Marionis*, Perrier. S. France.
5. *Hormogaster Redii*, Rosa. Italy.
6. *Perichæta Sieboldi*, Horst. Japan. N., N', O., E., A.
7. *Perichæta japonica*, Horst. Japan.
8. *Perichæta Schmardæ*, Horst. Japan.
9. *Perichæta Houletti*. France. N', O.

¹ This species has at present only been recorded by Rosa [*Microscolex modestus*, n. gen. n. sp.—Boll. Mus. Zool. Torino, vol. ii. (1887), No. 19], who received it from Genoa. That the genus occurs in Tenerife I am to state here (for the first time), since I have examined a number of specimens kindly collected for me in that island by Mr E. B. Poulton, F.R.S. They may possibly belong to a distinct species, but I have not yet taken the opportunity of thoroughly working out their anatomy.

10. *Perichæta diffingens* (? = *P. indica*). England, France.
N', O., N.
11. *Lumbricus rubellus*, Hoffm. Europe. N'.
12. *Lumbricus melibæus*, Rosa. Italy.
13. *Lumbricus herculeus*, Sav. Europe. N'.
14. *Lumbricus Eiseni*, Lev. Europe.
15. *Lumbricus castaneus*, Sav. Europe. N'.
16. *Allolobophora fœtida*, Sav. Europe. N', N., A.
17. *Allolobophora rubicunda*, Eisen. Europe.
18. *Allolobophora trapezoides*, Eisen. Europe. N'.
19. *Allolobophora mucosa*, Eisen. Europe. N'.
20. *Allolobophora chlorotica*, Sav. Europe. N'.
21. *Allolobophora alpina*, Rosa. Italy.
22. *Allolobophora constricta*, Rosa. Italy.
23. *Allolobophora minima*, Rosa. Italy.
24. *Allolobophora Boeckii*, Eisen. Europe. N'.
25. *Allolobophora transpadana*, Rosa. Italy.
26. *Allolobophora profuga*, Rosa. Italy, Spain.
27. *Allolobophora complanata*, Dugès. France, Italy, Spain.
28. *Allolobophora Tellinii*, Rosa. Italy.
29. *Allolobophora celtica*, Rosa. Italy.
30. *Allolobophora veneta*, Rosa. Italy, Portugal.
31. *Allolobophora Ninnii*, Rosa. Italy.
32. *Allolobophora icterica*, Sav. France, Italy.
33. *Allolobophora gigas*, Dugès. France.
34. *Allolobophora Fraissei*, Örley. Balearic Is.
35. *Allolobophora mediterranea*, Örley. Balearic Is.
36. *Allolobophora Molleri*, Rosa. Portugal.
37. *Allolobophora tenuis*, Eisen. Scandinavia. N'.
38. *Allolobophora Hispanica*, Ude. Spain.
39. *Allolobophora Hermannii*, Mich. Germany.
40. *Allolobophora neglecta*, Rosa. Italy.
41. *Allolobophora norvegica*, Eisen. Scandinavia.
42. *Allolobophora Nordenskiöldi*, Eisen. Siberia (?).
43. *Allolobophora limicola*, Mich.
44. *Allolobophora subrubicunda*, Eis. Scandinavia, Italy. N'.
45. *Allolobophora octaedra*, Sav. Europe.
46. *Allolobophora neapolitana*, Örley. Italy.
47. *Allolobophora longa*, Ude.
48. *Allolobophora trapezoides*, Dugès.
49. *Criodrilus lacuum*, Hoffm. Europe.

50. *Allurus tetraedrus*, Sav. N., N', A.
51. *Allurus dubius*, Mich. Germany.
52. *Allurus hercynius*, Mich. Germany.

The species of *Allolobophora* and *Lumbricus*, which are given in the above lists as occurring in the Palæarctic and Nearctic regions, require some explanation.

In the first place, I have omitted the synonyms. This was done advisedly, as the present paper does not profess to be a revision of the two genera. In the second place, I have accepted, without discussion, Rosa's names so far as possible. But in doing this, I do not necessarily imply that in my opinion Rosa's names are better founded than those of, for example, Vejdovsky. Confining myself to one naturalist's nomenclature, I select that of Rosa because it happens to be more familiar to me. As my purpose is that of comparing the earthworms of different countries, the question of names is obviously of no moment so long as the same name is applied to the same species. The above list is, I am aware, incomplete; but as there is some doubt about many species, I do not see any advantage in mentioning a number of more or less dubious names.¹

V. Oriental Region, O.

1. *Moniligaster deshayesi*,² E. P.
2. *Moniligaster Barwelli*, F. E. B. Manila.
3. *Moniligaster minutus*, Bourne. India.
4. *Moniligaster sapphirinoides*, Bourne. India.
5. *Moniligaster grandis*, Bourne. India.
6. *Moniligaster uniguus*, Bourne. India.
7. *Moniligaster robustus*, Bourne. India.
8. *Moniligaster papillatus*, Bourne. India.

I must, however, refer to two remarkable types recently described by Løvinson (Om to nye Regnormslægten fra Ægypten—Vid. Medd. nat. For. Kjøbenhavn, 1889), viz., *Siphonogaster ægyptiacus* and *Digitibranchus niloticus*. The latter is possibly *Alma nilotica*. Their affinities are uncertain.

² Whether these two species are really distinct from each other or from some of those described by Bourne (On Indian Earthworms, etc.—P. Z. S., 1886, pp. 662-672) is uncertain. Horst's *Moniligaster Houteni* (Descriptions of Earthworms, No. I.—Notes Leyd. Mus., ix., p. 97) may turn out also to be identical with one of Bourne's species.

9. *Moniligaster ruber*, Bourne. India.
10. *Moniligaster Houteni*, Horst. Sumatra.
11. *Cryptodrilus* sp. India. A., N'.¹
12. *Urochæta corethrura*, E. P. (= *U. dubia*, Horst). Malayan Archipelago. N., A.
13. *Glyphidrilus Weberi*, Horst.
14. *Typhæus orientalis*, F. E. B. Burmah.
15. *Typhæus Gammii*, F. E. B. Near Calcutta.
16. *Typhæus Masoni*, Bourne. India.
17. *Perionyx excavatus*² (? incl. *P. m'intoshii*, F. E. B.). India and Burmah.
18. *Perionyx saltans*, Bourne. India.
19. *Perichæta cærulea*, Templ. Ceylon.
20. *Perichæta affinis*, E. P. India, Ceylon, Manilla, Burmah. N.
21. *Perichæta armata*, F. E. B. India, Burmah, Borneo.
22. *Perichæta Houletti*, E. P. India, Ceylon. N.
23. *Perichæta ceylonica*, F. E. B. Ceylon.
24. *Perichæta Lawsoni*, Bourne. India.
25. *Perichæta bivaginata*, Bourne. India.
26. *Perichæta gracilis*, Bourne. India.
27. *Hoplochæta Stuarti*, Bourne. India.
28. *Perichæta burliarensis*, Bourne. India.
29. *Perichæta hulikalensis*, Bourne. India.
30. *Perichæta mirabilis*, Bourne. India.
31. *Perichæta salettensis*, Bourne. India.
32. *Perichæta indica*, Horst. India, Sumatra, Java. N., A.
33. *Perichæta luzonica*, E. P. Manilla.
34. *Perichæta Vaillanti*, F. E. B. Manilla.
35. *Perichæta annulata*, Horst. Malayan Archipelago.
36. *Perichæta musica*, Horst. Java.
37. *Perichæta Hasselti*, Horst. Sumatra.
38. *Perichæta sumatrana*, Horst. Sumatra.
39. *Perichæta biserialis*, E. P. Manilla.
40. *Perichæta Horsti*, F. E. B. Manilla.
41. *Perichæta quadragenaria*, E. P. East Indies.
42. *Perichæta Fex*, Rosa. Burmah.

¹ I received some time since from the Botanical Gardens at Seebpore a single example of a worm apparently belonging to this genus. Unfortunately, the specimen is now missing.

² I suppose that Rosa is right in uniting these two (cf. Rosa, I lombrichi raccolti nell' isola Nias, etc.—Ann. Mus. civ. Genova, vol. vii., 1889).

43. *Perichæta modigliani*, Rosa. Nias.
 44. *Deodrilus Jacksoni*, n. gen., n. sp. Ceylon.

The following insufficiently known species are from this region :—

- Perichæta Juliana*, E. P. Saigon.
Perichæta cœrulea, E. P. Manilla.
Perichæta bicincta, E. P. Manilla.
Perichæta leucocycla, Schm. Ceylon.
Perichæta viridis, Schm. Ceylon.
Perichæta brachycycla, Schm. Ceylon.
Perichæta cingulata, Schm. Ceylon.
Perichæta javanica, Kinb. Java.

VI. Australian Region, A.

1. *Perichæta exigua*, Fl. Australia. N., O., E.
2. *Perichæta monticola*, Fl. „
3. *Perichæta canaliculata*, Fl. „
4. *Perichæta stirlingi*, Fl. „
5. *Perichæta raymondiana*, Fl. „
6. *Perichæta hamiltoni*, Fl. „
7. *Perichæta wilsoniana*, Fl. „
8. *Perichæta fecunda*, Fl. „
9. *Perichæta bakori*, Fl. „
10. *Perichæta dorsalis*, Fl. „
11. *Perichæta tenax*, Fl. „
12. *Perichæta austrina*, Fl. „
13. *Perichæta gracilis*, Fl. „
14. *Perichæta barronensis*, Fl. „
15. *Perichæta queenslandica*, Fl. „
16. *Perichæta darnleiensis*, Fl. „
17. *Perichæta peregrina*, Fl. „
18. *Perichæta australis*, Fl. „
19. *Perichæta coxii*, Fl. „
20. *Perichæta newcombei*, F. E. B. „
21. *Perichæta upoluensis*, F. E. B. Upolu.
22. *Perichæta Forbesi*, F. E. B. New Guinea.
23. *Perichæta intermedia*, F. E. B. New Zealand.
24. *Perichæta antarctica*, Baird. „

25. *Perichæta indica*, Horst. New Caledonia.
26. *Eudrilus dubius*,¹ Fl. Australia.
27. *Eudrilus Boyeri*, F. E. B.² New Caledonia. N., E.
28. *Perissogaster excavata*, Fl. Australia.
29. *Anisochæta attenuata*, Fl. „
30. *Anisochæta enormis*, Fl. „
31. *Anisochæta Coxii*, Fl. „
32. *Allolobophora trapezoides*, Dugès. N., P.
33. *Allolobophora fœtida*, Sav. N., N', P.
34. *Allolobophora profuga*, Rosa. P.
35. *Cryptodrilus rubens*, Fl. Australia. O., N.
36. *Cryptodrilus rusticus*, Fl. „
37. *Cryptodrilus saccarius*, Fl. „
38. *Cryptodrilus mediterreus*, Fl. „
39. *Cryptodrilus unicus*, Fl. (= *C. purpureus*, Mich.). Australia.
40. *Cryptodrilus Fletcheri*, F. E. B. Australia.
41. *Cryptodrilus mulgeanus*, Fl. „
42. *Cryptodrilus canaliculatus*, Fl. „
43. *Cryptodrilus Sloanei*, Fl. „
44. *Cryptodrilus oxleyensis*, Fl. „
45. *Cryptodrilus manifestus*, Fl. „
46. *Cryptodrilus fastigatus*, Fl. „
47. *Cryptodrilus tenuis*, Fl. „
48. *Cryptodrilus mediocris*, Fl. „
49. *Cryptodrilus illawarræ*, Fl. „
50. *Cryptodrilus singularis*, Fl. „
51. *Digaster Perrieri*, Fl. „
52. *Digaster lumbricoides*, E. P. „
53. *Perissogaster nunoralis*, Fl. „
54. *Perissogaster queenslandica*, Fl. „
55. *Megascolides camdenensis*, Fl. „
56. *Megascolides grandis*, Fl. „
57. *Megascolides gippslandicus*, M'Coy. „
58. *Megascolides tasmanianus*, Fl. „
59. *Megascolides tuberculatus*, Fl. „
60. *Megascolides illawarræ*, Fl. „
61. *Megascolides pymæus*, Fl. „

¹ This species is considered by Rosa to be a *Microscolex*.

² *Eudrilus Boyeri* is not, perhaps, very easily definable as distinct from *E. decipiens*, or either of the other two species of *Eudrilus* described by Perrier from the New World.

62. *Dichogaster Damonis*, F. E. B. Fiji.
63. *Acanthodrilus australis*, Mich. Australia. N., N', E.
64. *Acanthodrilus novæ Zelandiæ*, F. E. B. New Zealand.
65. *Acanthodrilus dissimilis*, F. E. B. „
66. *Acanthodrilus neglectus*, F. E. B. „
67. *Acanthodrilus multiporus*, F. E. B. „
68. *Acanthodrilus Rosæ*, F. E. B. „
69. *Acanthodrilus annectens*, F. E. B. „
70. *Acanthodrilus antarcticus*, F. E. B. „
71. *Rhododrilus minutus*, F. E. B. „
72. *Acanthodrilus unguatus*, Perrier. New Caledonia.
73. *Acanthodrilus Layardi*, F. E. B. „
74. *Urochæta australiensis*,¹ F. E. B. Australia. N., O.
75. *Deinodrilus Benhami*, F. E. B. New Zealand.
76. *Neodrilus monocystis*, F. E. B. „

This list may be increased by the addition of the following forms, which are unrecognisable; in many cases even the generic name is probably wrong; these are queried:—

- Acanthodrilus uliginosus*, Hutton. New Zealand.
- ‡ *Digaster lævis*, Hutton. „
- ‡ *Digaster campestris*, Hutton. „
- ‡ *Lumbricus annulatus*, Hutton. „
- Perichæta sylvestris*, Hutton. „
- Perichæta lineata*, Hutton. „
- Pheretima* (= *Perichæta*) *montana*, Kinb. Otaheiti.
- Perichæta taiensis*, Grube. Otaheiti.
- Perichæta subquadrangularis*, Grube. Viti.
- Perichæta æriginosa*, Kinb. Guam.
- Perichæta corticis*, Kinb. Hawai.
- ‡ *Lumbricus tahitanus*, Kinb. Otaheiti.
- ‡ *Lumbricus tongaensis*,² Grube. Tonga
- Eudrilus* sp. ‡ (*fide* Benham). New Zealand.
- ‡ *Hypogæon havaicus*, Kinb. Hawai.
- ‡ *Hypogæon orthostichon*, Schm. New Zealand.

A glance at the above lists does not at first seem to permit of the deduction of any general statements respecting

¹ I have not yet described this species, but I believe it to be distinct from *U. corethrura*.

² Certainly not *Lumbricus*, as clitellum extends from xliith to xviiiith segment.
‡ *Dichogaster*.

the distribution of the group, except that many genera and some species have a world-wide distribution.

This is especially the case with the genera *Lumbricus*, *Allolobophora*, and *Perichæta*.¹

But it is necessary, in the first place, to clear the ground by removing from the various faunal lists those species which have been accidentally introduced by man's agency. This is obviously not an easy task. The first question which arises is, have we any right at all to suppose that this has been the case? I content myself with urging the general probability, owing to the importation of plants from country to country, and to mentioning one or two instances which are only explicable on this theory. Some years ago the late Dr Baird, of the British Museum, described in the *Proceedings of the Zoological Society* a species of *Perichæta* (*P. diffringens*) which had been sent to him from various parts of England, but always from conservatories or from gardens for the adornment of which plants had been imported from abroad.

In the Jardin des Plantes Perrier met with *Perichæta Houletti*, a species which has not been met with in any other part of Europe.

Both these cases (and others might be quoted) seem to show that the species of *Perichæta* are in all probability not indigenous, otherwise they would have been met with in other places besides the immediate neighbourhood of plants which had been recently imported from the countries of which the species in question are certainly natives.

Two examples which have come under my own observation may be mentioned as proving beyond a doubt (if indeed there could be any doubt upon the point) that earthworms may be carried from abroad to this country.

¹ With the exception of the doubtful case of *Lumbricus* and *Allolobophora*, the following are the only *species* which are known to occur in more than one region :—

<i>Urochæta corethrura.</i>	Neotropical and Oriental.
<i>Perichæta affinis.</i>	„ „
<i>Perichæta Houletti.</i>	„ „
<i>Perichæta indica.</i>	„ „ and Australian.
<i>Eudrilus decipiens.</i>	Neotropical and Australian.

Mr Clarence Bartlett kindly presented me with two earth-worms, one being an example of *Perichæta indica*, which he had found in the earth surrounding the roots of some orchids which had been recently imported by him from South America.

A package of ferns from New Zealand contained a large number of specimens of *Allolobophora* and *Lumbricus* (I have not identified the species) which had survived the long voyage. For these I am indebted to the same gentleman.

The next matter is to decide which forms have been probably introduced, and which are really indigenous. It is, of course, impossible to do more than make a reasonable assumption, which further progress in our knowledge may prove to be an unwarrantable assumption. Taking into consideration what we know of the occurrence of *Perichæta* in Europe and North America, it may be safely inferred that this genus is *not* indigenous in either of these countries, but that it is indigenous in a portion of the Palæarctic region—viz., in Japan.¹

With regard to *Lumbricus* and *Allolobophora*, these genera unquestionably form the predominant types in Europe and North America. They far outnumber the other genera not only in variety of species but in number of individuals. It cannot, therefore, be doubted that they are indigenous to these parts of the world. On the other hand, comparatively few species of *Lumbricus* and *Allolobophora* have been recorded from other countries. In New Zealand, for example, the genus *Acanthodrilus* outnumbers *Lumbricus* and *Allolobophora*. In South America the many peculiar genera include a total number of species which is greater than that of the few Anticlitellian worms which have been recorded from that continent. Dr Michaelsen,² in an important contribution

¹ Three species have been described by Horst (New Species of the Genus *Megascolex*, etc.—Notes Leyd. Mus., vol. v., p. 182) from Japan. In a collection which Professor Milne made for me at the kind request of Dr Anderson, there were examples of *Perichæta* which were quite as numerous as *Allolobophora fatida*, the only other species contained in the collection. This is some evidence that the genus *Perichæta* is common in Japan. I have not identified the species.

² Oligochæten des naturhistorischen Museums in Hamburg—J. B. Hamb. Wiss. Anstalt vi.

to the earthworm fauna of Chili, places after each of the three Lumbricidæ the word "eingeschleppt," and I am quite disposed to agree with him. Moreover, many of the so-called "*Lumbricus*" which occur in South America and in other extra-European countries, are certainly *not* referable to this genus or to *Allolobophora*. Pending the production of evidence to the contrary, I do not admit that the genera *Lumbricus* and *Allolobophora* are indigenous to any countries but Europe, Northern Asia, and North America.

It is, however, a difficult task to proceed further with the elimination of those facts in geographical distribution which have been caused by the direct, though unconscious, interference of human agency.

There are not many cases, fortunately, which suggest that this explanation should be called in. The most prominent is that of *Eudrilus*. This genus is common in South America, and in some of the West Indian islands (Bahamas); it is also apparently common in New Caledonia, and occurs in New Zealand. It was first recorded by myself from New Caledonia on the strength of some specimens which I received through the kindness of Mr E. L. Layard, H.B.M. Consul at Noumea. These specimens I described as *Eudrilus Boyeri*, but it may be, as Horst has suggested, that this supposed species is not really different from Perrier's *Eudrilus* from South America. I wrote to Mr Layard to inquire if there was such trade between these two distant parts of the world as might reasonably account for the introduction of South American forms. He informed me that there was not, and that the chief trade was with Australia. The genus *Eudrilus* has been described as occurring in this latter country by Fletcher; but I have not included the genus in my list of Australian genera, for the reason that it cannot be considered to be proved that Fletcher's *Eudrilus dubius* is really a member of the genus. Rosa¹ has suggested that it is probably referable to his *Microscolex*. As *Eudrilus* occurs in New Zealand, it *may* also occur in Australia, but the fauna of these two countries differs quite as much in respect of

¹ Nuova Classificazione dei Terricoli—Boll. Mus. Zool. Torino, vol. iii., No. 41, p. 15.

Oligochaeta as in other animals. *Eudrilus* also is a genus which is to a certain extent a primitive form. The opening of the vasa deferentia into the atria, and the presence of two pairs of ovaries and oviducts¹ are primitive characters. For the present I regard the presence of *Eudrilus* in the tropical parts of the New World and in New Caledonia and New Zealand as a fact of importance in the geographical distribution of the genus, not caused recently by man's interference.² Another doubtful case is *Urochaeta*. This genus occurs in South America, the West Indies, the Malay Archipelago, and Western Australia. The fact, however, that the Australian form is specifically different from that of America, lends very strong support to the view that this fact of distribution is also to be regarded as normal.

The following genera exist in more than one geographical region :—

Perichaeta, P., World-wide.

Acanthodrilus, E., N., A., N'. *Cryptodrilus*, A., O., N. (?)

Urochaeta, N', O., A.

Eudrilus, N', A.

Microscolex, P., A.

Lumbricus, World-wide.

Allolobophora, World-wide.

Allurus, N', P., E.

while the following are limited to their region, with a wider or more restricted range within it.

TABLE OF GENERA PECULIAR TO DIFFERENT REGIONS.

Neotropical.		Australian.	
	<i>Diachaeta</i> .		<i>Megascolides</i> .
	<i>Urobenus</i> .		<i>Rhododrilus</i> .
	<i>Trigaster</i> .		<i>Aporochaeta</i> .
	<i>Anteus</i> .		<i>Deinodrilus</i> .
	<i>Geoscolex</i> .		<i>Dichogaster</i> .
	<i>Onychochaeta</i> .		<i>Neodrilus</i> . ³
	<i>Rhinodrilus</i> .		<i>Anisochaeta</i> .

¹ BEDDARD, Contributions to the Anatomy of Earthworms, No. 1—P. Z. 8., 1887, p. 383.

² This opinion is confirmed by Michaelsen's recent description of a closely allied form from Africa.

³ I do not consider that Fletcher's genus, *Perisogaster*, is well established. My *Neodrilus* is also doubtful (see Proc. Roy. Soc. Edin., vol. xiv., 1887, p. 157).

Palæarctic.	<i>Hormogaster.</i>	Ethiopian.	<i>Microchaeta.</i>
	<i>Pontodrilus.</i>		<i>Teleudrilus.</i>
	<i>Photodrilus.</i>		<i>Pygmæodrilus.</i>
	<i>Criodrilus.</i>		<i>Callidrilus.</i>
Nearctic.	<i>Tetragonurus.</i>		<i>Polytoreutus.</i>
	<i>Plutellus.</i>		<i>Stuhlmannia.</i>
Oriental.	<i>Moniligaster.</i>		<i>Eudriloides.</i>
	<i>Typhæus.</i>		<i>Nemertodrilus.</i>
	<i>Glyphidrilus.</i>		
	<i>Hoplochæta.</i>		
	<i>Deodrilus.</i>		

How far is the distribution of earthworms in accordance with Mr Sclater's regions ?

It is perfectly clear that the Neotropical region—at least the tropical parts of that region—is very distinct ; it contains as many or more peculiar genera than any other region. An American region (Andrew Murray), or a Boreal region (including the Palæarctic and Nearctic regions of Mr Sclater, with Central and a good portion of South America), such as that proposed by Mr Blyth, will not be at all in accordance with the facts of this paper. *Plutellus* may be a Neotropical form, which has made its way northwards, and *Acanthodrilus communis* certainly has done so ; but the facies of the two faunas is *very* distinct. Except *Acanthodrilus*, unless *Allolobophora* be counted, there are no genera in common ; and while *Lumbricus* and *Allolobophora* are the prevailing forms of the north, we have such genera as *Anteus*, *Eudrilus*, and *Geoscolex* in the south. The West Indies clearly go with South America, though they have their own peculiarities. It would be very interesting to have some information about Central America.

The Nearctic region cannot, so far as Earthworms are concerned, be separated from the Palæarctic ; although there are genera found in one region which do not occur in the other. The importance of this might easily be overrated. Four Palæarctic genera do not occur in the Nearctic region, and three Nearctic genera are absent from the Palæarctic region ; but it cannot be denied that the prevailing character-

istic of the earthworm fauna of both these regions is the abundance and prevalence of *Lumbricus* and *Allolobophora*, amounting to an identity of species. These facts therefore support the reasonableness of instituting an Arctogæa or Holarctic region, as it is termed by Heilprinn. The community of the earthworm fauna of the northern parts of the old and new worlds is of course explicable on the assumption of a recent land connection. The distribution of certain other animals (*e.g.*, the glutton, beaver, and elk) is in harmony with such a view, and there is no difficulty on the geological side of assuming such a connection by way of Behring Strait where the sea is shallow, and the distance from shore to shore small.

Dr Günther noticed that Japan differs more particularly than any other tract of country from the rest of the Palæ-arctic region, and resembles the Oriental.

We have already seen that in Japan (and possibly adjacent parts of China) alone is the genus *Perichæta* probably indigenous. Here, then, is a decided confirmation of Dr Günther's position.

Huxley proposed to separate New Zealand as a distinct region, while Heilprinn distinguishes a Polynesian region *not* including New Zealand. Is there anything to be said for either of these modifications of Mr Sclater's regions? We know too little of the earthworm fauna of Polynesia to make any deductions worth putting on paper; but New Zealand is better known.¹ It does *not* show a close resemblance to Australia. The prevailing genus in New Zealand is *Acanthodrilus*, which is there represented by five species. This genus is certainly not common in Australia; in fact only one species, *A. australis*, has been as yet met with. And we have the careful investigations of Fletcher² for reference, which must comprise a fair sample of the earthworm fauna of South-Western Australia—the nearest part to New Zealand. On the other hand, our knowledge of the earthworm fauna of New Zealand is confined to that of the

¹ The Oligochæteous Fauna of New Zealand—P. Z. S. (1889), p. 377.

² Notes on Australian Earthworms—a series of papers in Proc. Lin. Soc. N.S.W. (1886-89).

Southern Island. The North Island may prove to be more "Australian" in its character, when it comes to be known. If it were not for the fact that in New Caledonia *Acanthodrilus* is a characteristic form, the earthworm fauna of New Zealand would, perhaps, rather support Professor Huxley's view of its independence as a separate region.

This is the place to point out the very striking resemblance that exists between many parts of the Antarctic hemisphere in respect of their terrestrial Oligochæta.

Patagonia and the Falkland Islands have between them four species of earthworms which are *all* referable to the genus *Acanthodrilus*. Although other species may be met with, this genus is hardly likely to prove anything but most characteristic. From South Georgia only one species of earthworm has been described (*Acanthodrilus georgianus*), which also occurs in the Falklands. Kerguelen and Marion Islands have not, perhaps, been very thoroughly explored, but it is remarkable that the only form which has been discovered should be identical in the two islands, and should be a species of *Acanthodrilus*. In South Africa the genus *Acanthodrilus* occurs; but although several species have been described from the African continent, the genus cannot at present be exactly regarded as characteristic.

It is possible that this similarity between such widely removed parts of the earth's surface as those enumerated above may be caused by their nearness to the Antarctic continent, from which they were all originally stocked. This is more credible than the assumption by some of a former direct land connection between New Zealand and South America. It might, perhaps, be believed that the distribution of the genus *Acanthodrilus* had a relation to temperature, were it not for the fact that species have been found in Africa near to, but north of, the Equator. The distribution of this genus is in some respects paralleled by that of the marine Isopodan genus *Serolis*, and of the Penguins and Sheathbills among birds, and of the Coleoptera among insects.¹ It must surely have originated in the Antarctic continent, and have gradually spread northwards. The species are

¹ Heilprinn, *loc. cit.*, p. 281.

decidedly more numerous the closer we get to the Antarctic continent. In America, for example, there are four species found in S. Georgia, the Falklands, and Patagonia, two in Chili, and one in North America. I have mentioned a few instances here; but Mr Blanford has lately argued with considerable force in favour of an ancient land connection between these countries by the extension of the Antarctic continent. Quoting many instances of closely-allied forms of life, and especially laying stress upon the facts that America and New Zealand are not separated by a depth greater than 2000 fathoms from the southern land mass, he also points out that there are not any soundings due south of Cape of Good Hope; hence it is possible that the ocean here may be no deeper.

On the other side, we have seven species in New Zealand as against *one* in Australia.

The African continent does not, it is true, furnish much evidence for this position as far as decrease of species as we pass northwards is concerned; but, on the other hand, the absence(?) of the genus from North Africa, and at any rate its certain absence from Europe, shows that either the Desert of Sahara or the Mediterranean has formed a bar sufficient to prevent the immigration of this genus *from the south northwards*.

There is an unmistakable agreement also between the Old and New World tropics. The following generic types are common to the two:—*Perichæta*, *Urochæta*, and *Rhino-drilus*. On the other hand, the genera *Diachæta*, *Onychochæta*, *Urobenus*, *Trigaster*, *Geoscolex*, and *Anteus* are peculiar to the New World; while *Typhæus*, *Perionyx*, and *Moniligaster* are peculiar to the Old.

There is not a marked agreement in species. *Urochæta corethrura*, *Perichæta indica*, *P. affinis*, and *P. Houletti* are the only forms which are common to the Neotropical and Oriental regions.

This resemblance is probably largely due to climatal causes. *Perichæta*, although an almost world-wide genus, is decidedly more abundant as we approach the hotter regions.

It is an old form, and has, therefore, had time to spread widely, like the tapir and *Peripatus*.

But although the resemblance may have something to do with climatal causes, the evidence at our disposal by no means supports any theory of climatal distribution and division of the world into faunal zones.

The Australian region, at any rate as regards the Australian continent, has a somewhat peculiar earthworm fauna. Apart from *Perichæta* and *Megascolex*, which occur here as in almost all parts of the world, there is the peculiar genus *Anisochæta*, which connects *Perichæta* with *Cryptodrilus*.¹ This latter genus is, with the exception of two species, confined to Australia. It and *Megascolides*, *Digaster*, and *Didymogaster*,² which are absolutely confined to Australia, are the most characteristic genera of that continent. *Urochæta* is represented in Queensland by a distinct species.³ *Acanthodrilus* is represented by one species, as is also *Microscolex* (Rosa considers that Fletcher's *Eudrilus dubius* is probably really to be referred to that genus). The bulk of the Australian earthworms therefore belong to Rosa's family *Eudrilidæ* (which, as it appears to me, is a very natural family, if only *Eudrilus* itself be excluded!). Out of the remaining eight genera of this family, three—viz., *Neodrilus*, *Rhododrilus*, and *Dichogaster*—are confined to the Australian region, though not inhabiting Australia itself. Of the remaining five, *Pontodrilus* and *Photodrilus* are Palearctic, while *Typhæus* is Oriental, in fact, Indian, and *Eudriloides* and *Callidrilus* are Ethiopian.

The Australian area, especially the Australian continent, forms, therefore, a very well-marked distributional region, which has something—though little—in common with the Oriental region.

Oceanic islands are naturally—from their origin—not

¹ I regard Michaelsen's *Cryptodrilus purpureus* (= *unicus*, Fl.) as representing a new genus. I discuss the reasons for this in a forthcoming paper.

² Fletcher's *Perissogaster* does not appear to me to be a valid genus.

³ I hope to show elsewhere that some examples of *Urochæta*, which I described from Queensland some years ago (Observations on the Structural Characters of certain new or little known Earthworms—Proc. Roy. Soc. Edin., vol. xiv., 1887, p. 160 *et seq.*), are distinct from *U. corethrura*.

inhabited by purely terrestrial animals which are not gifted with means of crossing the ocean. There are, however, exceptions to this rule, which are not a little puzzling—such as, for example, the occurrence of *Rana Guppeyi* in the Solomon Islands. Earthworms form another exception. Apart from the islands of the Pacific, which are for the most part separated from each other by such narrow tracts of ocean that an accidental transfer of species is credible, we have earthworms occurring in Madeira, Tenerife, St Helena, Fernan Noronha, Marion Island, Kerguelen, and South Georgia. Tenerife is included in the Palæarctic region, and the justice of this conclusion is borne out by a consideration of its earthworms. Through the kindness of Mr E. B. Poulton, F.R.S., and Mr F. W. Headley, I have become possessed of a number of earthworms from that island belonging to the genera *Microscolex*, *Allurus*, and *Allolobophora*. This resemblance, however, may perhaps be only the result of a more active commercial intercourse with Europe than with any other part of the world. St Helena is inhabited by several species of earthworms belonging to the genus *Perichaeta*. But the most interesting occurrence of earthworms on any oceanic islands is their occurrence in Kerguelen and Marion Islands. On each of these islands one species occurs, which appears to be the same. As Lankester's *Acanthodrilus kerguelensis* was adequately described, while Grube's *Lumbricus kerguelarum* was—to avoid all semblance of exaggeration—inadequately described, I retain the former name, though the species are probably identical.

There is obviously not sufficient intercourse between Kerguelen and other parts of the world to account for the artificial introduction of this *Acanthodrilus*; and, as it differs specifically from any form hitherto described, it has probably occupied the islands for a considerable period. Kerguelen itself is an island of considerable age, as is evinced by the fact that it possesses sedimentary rocks (formed, however, exclusively out of the *débris* of its volcanic substructure).¹ I point out elsewhere that Kerguelen forms part of an Antarctic

¹ Since the above was written, Mr Blanford's "Presidential Address" to the Geological Society has appeared. I have quoted on p. 286 some other

faunal area, including New Zealand and Patagonia; this is shown in many groups, both terrestrial and marine. Probably Kerguelen and these other countries were stocked from an Antarctic continent which was in a comparatively recent geological period inhabited by terrestrial animals.

TABLE INDICATING NUMBER OF GENERA IN DIFFERENT REGIONS.

	Genera.	Peculiar Genera.	Percentage.
Palæarctic,	8	4	50·0
Ethiopian,	10	7	70·0
Oriental,	9	5	50·5
Nearctic,	5	3	60·0
Neotropical,	11	6	50·4
Australian,	11	7	63·6

We cannot, of course, at present pay much regard to the numbers given for the Ethiopian region, it has been too little explored; but of some of the other regions, particularly the Palæarctic and Australian, we have a fair knowledge. It is noticeable that, as in Vertebrata,¹ the Ethiopian, Neotropical, and Australian regions have the largest number of peculiar forms, and the Nearctic the smallest. The genera allowed are those given in the faunal lists on pp. 269-278, with the exception of the doubtful ones marked in those lists with a query.

Chief Facts contained in the above.

(1.) The close resemblance between the Nearctic and Palæarctic regions necessitating their fusion into a Holarctic region.

(2.) The separation of Japan from the Palæarctic, and its relegation to the Oriental region.

(3.) The great richness of South America and Australia in peculiar types.

suggestions from this important contribution to the subject under discussion. He remarks, with reference to Kerguelen, that it is far from clear that its volcanic formations do not belong to the continental type.

¹ Wallace, *Geographical Distribution of Animals*, vol. i., p. 81.

(4.) The wide distribution of *Acanthodrilus* in the land masses of the Southern hemisphere, which agree in the great abundance of species of this genus and comparative rarity of other forms.

(5.) The marked difference between New Zealand and Australia.

EXPLANATION OF MAPS.

PL. XIII. The distribution of the Acanthodrilidæ is shown in red.

PL. XIV. The dots indicate the areas occupied by the Eudrilidæ.¹ The cross lines indicate the areas occupied by the Perichetida. The dark red patches show when both families occur.

XXVI. *Notes upon the Marine Accumulations in Largo Bay, Fife, and at Portrush, County Antrim, North Ireland.*
By ALFRED BELL, Esq., London. (Communicated by
JAMES BENNIE, Esq.)

(Read 15th January 1890.)

LARGO BAY, FIFE.

Shortly before leaving London for Australia, Mr Robert Etheridge, jun., a former president of this Society, suggested to the writer that if ever opportunity served, a further examination of the fauna in the raised beds near the Cockle-mill Burn in Largo Bay would be desirable, as the list of species recorded by him in his paper upon these deposits, read before the Royal Physical Society, Edinburgh, vol. vi., p. 105 (1881), only embraced the larger forms. At a later period, thanks to the kindness of Mr J. Bennie, who had worked with Mr Etheridge, the smaller matter and floatings came into my hands, and from these and a second parcel from the same gentleman, and material obtained on a personal visit, the appended lists have been compiled.

The physical features of the deposit have been so carefully and thoroughly described by Mr Etheridge, that little can be added. On my visit the driving sands had partly obscured the face of the section, but not so far as to obliterate the traces of current bedding and lamination.

Agreeing with my friend that its origin is marine rather

¹ I have not referred in the text to the occurrence of two new genera of Eudrilidæ which I have just received from Lagos, W. Africa.

than subaerial, I am reluctantly compelled to differ from him in referring to it as a "raised beach."

Useful as the words "raised beach" may be as a geological term, they are not sufficiently explicit in a palæontological sense, because beach faunas have their own peculiarities differing in many respects from faunas accumulated under other conditions.

The fauna of a raised beach depends upon the nature of the beach itself. If a flat sandy shore, the sands and shells will be swept up beyond tide mark into dunes; if bounded by cliffs or a rocky shore, the organisms are usually much broken or swept off by recurring tides. A true beach fauna is confined to comparatively few species, usually *Littorina*, *Mytilus*, and *Cardium* (species that can live out of water for hours), except towards the verge of extremely low tides.

From the abundance of species, state of preservation, and mode of presentation, the Largo Bay accumulation appears to be a current-bedded sand-bank formed in the laminarian zone, the remains being proper to that horizon, heaped up between Kincaig on the east and Kilconquhar on the north.

One of the most important features in this deposit are the number of mollusca (nearly 13 per cent.) not found living in the Firth of Forth at the present time, taking the lists¹ of Messrs Leslie and Herdman as a standard to go by. Further research will probably reduce the number of missing species, but it is certainly desirable to call notice to these, and to the Foraminifera, of which nearly 50 per cent. do not occur in the above lists.

This may indicate a considerable lapse of time since the formation of the deposit, but does not carry it back to the age of the Clyde beds, containing *Tellina calcarea* and *Leda pernula*, whose nearest habitat is Fair Isle and the Faroes—deposits usually called raised beaches, but are more properly raised sea-bottoms.

The lists are still incomplete, as a further examination shows the existence of other organisms—Entomostraca and other things,—of which a list will be afforded at a later period when identified.

¹ The Invertebrate Fauna of the Firth of Forth. Edinburgh, 1881. Reprinted from Proc. Roy. Phys. Soc. Edin., vol. xi., pp. 68, 201, 268.

SPECIES OBTAINED FROM THE LARGO BEDS.

- Chiton cinereus*, L.
Patella vulgata, L.
Pilidium fulvum, Müll.
Helcion pellucidum, L.
Tectura virginea, Mont.
Emarginula fissura, L.
Trochus cinerarius, L.
 helicinus, Fabr.
Lacuna divaricata, Fabr.
 pallidula, Da Costa.
 " " var. *neritoides*, L.
Littorina littorea, L.
 obtusata, Gmel.
 rudis, Maton.
 " " var. *jugosa*, Mont.
 saxatilis, Johnst.
 tenebrosa, Mont.
 * *Rissoa abyssicola*, E. F.
 * " *albella*, Lov.
 * " *inconspicua*, Ald.
 parva, Da Costa.
 " " var. *discrepans*, E. F.
 " " var. *interrupta*, Ad.
 reticulata, Mont.
 striata, Ad.
 vitrea, Mont.
 * " *zelandica*, Mont.
 * *Barlecia rubra*, Mont.
Hydrobia ulva, Penn.
Skenea planorbis, Fabr.
Homalogyra atomus, Phil.
Cæcum glabrum, Mont.
Turritella terebra, L.
Aclis unica, Mont.
Odostomia acuta, Jeffr.
 * " *clavula*, Lov.
 * " *conoidea*, Broc.
 interstincta, Mont.
 obliqua, Ald.
 * " *plicata*, Mont.
 spiralis, Mont.
 turrita, Hanley.
 * " *truncatula*, Jeffr.
 umbilicatula, Malm.
 * (*Chemnitzia*) *lactea*, L.
 * " *rufa*, Phil.
Natica catena, Da Costa.
 Alderii, E. F.
- Aporrhais pespelicani*, L.
Purpura lapillus, L.
 " " var. *imbricata*, Lamk.
Buccinum undatum, L.
Nassa incrassata, L.
Pleurotoma costata, Don.
Cylichna umbilicata, Mont.
Utriculus obtusus, Mont.
 Lajonkairii, Bast.
 truncatulus, Brug.
Anomia ephippium, L.
 patelliformis, L.
Ostrea edulis, L.
Pecten opercularis, L.
 pusio, L.
 varius, L.
Mytilus Adriaticus, Lamk.
 edulis, L.
Nucula nitida, Sow.
 nucleus, L.
Montacuta bidentata, Mont.
 ferruginosa, Mont.
Lasea rubra, Mont.
Lucina borealis, L.
 * *Loripes lacteus*, L.
Axinus flexuosus, Mont.
Cardium edule, L.
 fasciatum, Mont.
Diplodonta rotundata, Mont.
Cyprina islandica, L.
Venus casina, L.
 ovata, Penn.
 striatula, L.
Tapes pullastra, Mont.
 virginea, L.
Artemis linctia, Pult.
Tellina balthica, L.
 fabula, Gron.
 tenuis, Da Costa.
Psammobia ferroensis, Chemn.
Macra solida, L.
 " " var. *elliptica*, Br.
 stultorum, L.
 subtruncata, Da Costa.
Lutraria elliptica, Lamk.
Scrobicularia piperata, Gmel.
Syndosmya alba, W. Wood.
 tenuis, Mont.

<i>Solen siliqua</i> , L.	<i>Balanus balanoides</i> .
<i>Thracia papyracea</i> , Poli.	„ <i>crenatus</i> .
<i>Corbula gibba</i> , Olivi.	<i>Echinus esculentus</i> .
<i>Saxicava rugosa</i> , L.	<i>Spatangus purpureus</i> .
* <i>Panopea fragilis</i> , Mont.	<i>Cellaria fistulosa</i> .
<i>Pholas candida</i> , L.	<i>Sphenotrochus macandrewanus</i> , M. Edw.
„ <i>crispata</i> , L.	<i>Cliona</i> .

For the accompanying list of Foraminifera I am indebted to Mr F. Chapman, who has kindly worked them out for me. Species so marked (*) are not in the lists of Messrs Leslie and Herdman.

- Miliolina seminulum*, L. Very common.
- * „ *circularis*, Born. Somewhat rare.
- * „ *bicornis*, W. and J. Very rare.
- * „ *oblonga*, Mont. Very common.
- Spiroloculina limbata*, D'Orb. Very rare.
- * *Cristellaria rotulata*, Lam. Very rare.
- Truncatulena lobatula*, Lam. Very abundant.
- * „ *variabilis*, D'Orb. Rare.
- Rotalia Beccarii*, L. Common.
- Polystomella striatopunctata*, F. and M. Very common.
- * „ *crispa*, L. Common.

Sphenotrochus Macandrewanus appears to be very rare. I have seen but one worn example. It is not referred to by Messrs Leslie and Herdman.

To Mr Thomas Scott, F.L.S., I am indebted for the following valuable list of Ostracoda detected by him in the finer silt:—

LIST OF OSTRACODA from Cocklemill Burn, Largo Bay.

- Cythere lutea*, Müller. Frequent.
- „ *villosa* (G. O. Sars). Frequent.
- „ *pulchella*, Brady. Few.
- „ *confusa*, Brady and Norman. Frequent.
- „ *angulata* (G. O. Sars). Not common.
- „ *finmarchica* (G. O. Sars).
- „ *convexa*, Baird. Rare.
- „ *albomaculata*, Baird. Common.
- „ *tenera*, Brady. Not common.
- „ *robertsoni*, Brady. Rare.
- Loxococoncha tamarindus* (Jones). Not common.
- „ *guttata* (Norman). Not common.

Xestolebris depressa, G. O. Sara. Rather rare.

Eucythere declivis (Norman). Rare.

Cytheridea elongata (Brady). Common.

„ *papillosa*, Bosquet. Rare.

Cytherura undata, G. O. Sara. Rare.

„ *sella*, G. O. Sara. Rare.

The nearest habitat of the Mollusca no longer present in the Forth (so far as ascertained till the present), according to Dr Gwyn Jeffreys, is for

<i>Rissoa abyssicola</i> , . . .	Shetland.
„ <i>albella</i> , . . .	Shetland.
„ <i>inconspicua</i> , . . .	Coralline zone everywhere.
„ <i>Zelandica</i> , . . .	Aberdeenshire.
<i>Barlecia rubra</i> , . . .	Aberdeenshire.
<i>Odostomia clavula</i> , . . .	Hebrides.
„ <i>conoidea</i> , . . .	Coralline zone, 25 to 80 fathoms.
„ <i>plicata</i> , . . .	S. W. England.
„ <i>truncatula</i> , . . .	Plymouth.
(<i>Chemnitzia</i>) <i>lactea</i> , . . .	Aberdeenshire.
„ <i>rufa</i> , . . .	S. W. England. A variety occurs in E. Scotland, 30 to 90 fathoms.
<i>Loripes lacteus</i> , . . .	Buchan.
<i>Diplodonta rotundata</i> (!),	Yorkshire (Whitburn).
<i>Panopea fragilis</i> , . . .	Moray Frith.

PORTRUSH, COUNTY ANTRIM.

The only accumulation that can be placed on line with the deposit just referred to, that I am aware of, is the one discovered but never described by the father of glacial geology, Mr James Smith of Jordanhill, and only briefly referred to in his collected papers ("Newer Pliocene Geology," Glasgow, 1862, pp. 74-84). The fullest lists of the fossils are those contained in General Portlock's "Geology of Londonderry," and in Canon Grainger's notice (*Brit. Ass. Adv. Sc. Reports*, 1874). Mr John Kelly of the Irish Survey has also examined these beds (*Trans. Roy. Irish Academy*).

Under these circumstances, it may be permitted me I hope to place on record as complete a list as possible of the fauna of this raised bed, most of the species recorded by General Portlock having been since verified by myself, and

his synonymy, somewhat complicated, brought into harmony with modern standards. As in Largo Bay,¹ all the species are still living somewhere in British waters. Land shells are not uncommon, but are more incorporated in the body of the main mass than is the case with the Largo beds, where they occur mostly in the higher portions of the deposit. Such interlopers are by no means uncommon, as I have collected them in the very marine quiescent beds of the Older and Newer Red Crags of East Anglia, the Quaternary residue at Selsey in Sussex, and the drifts on the east coast of Ireland and elsewhere.

FOSSILS FROM PORTRUSH, COUNTY ANTRIM.

The names in brackets are those adopted in Portlock's "Geology of Londonderry," etc.)

(<i>Terebratula cranium</i> ?) (Müll.)	<i>Cardium exiguum</i> , Gmel.
<i>Anomia ephippium</i> , L.	„ <i>fasciatum</i> , Mont.
„ var. <i>aquamula</i> , L.	„ <i>nodosum</i> , Turt.
„ var. <i>aculeata</i> , Müll.	„ <i>norvegicum</i> , Spengl.
„ <i>striata</i> , L.	(<i>C. elongatum</i> .)
„ <i>A. undulata</i> .)	<i>Cyprina islandica</i> , L.
<i>Ostrea edulis</i> , L.	<i>Astarte sulcata</i> , Da Costa.
<i>Pecten opercularis</i> , L.	(<i>Crassina scotica</i> .)
„ <i>pusio</i> , L.	„ <i>triangularis</i> , Mont.
(<i>P. distortus</i> .)	(<i>Macra triangularata</i> .)
„ <i>varius</i> , L.	<i>Circes minima</i> , Mont.
<i>Lima hians</i> , Gmel.	<i>Venus casina</i> , L.
<i>Mytilus edulis</i> , L.	„ <i>fasciata</i> , Da Costa.
„ var. <i>incurvata</i> , Penn.	„ <i>ovata</i> , Penn.
<i>Nucula nucleus</i> , L.	„ <i>striatula</i> , L.
(<i>N. margaritacea</i> .)	„ <i>verrucosa</i> , L.
„ <i>tenuis</i> , Mont.	<i>Tapes pullastra</i> , Mont.
<i>Arca lactea</i> , L.	<i>Donax villatus</i> , Da Costa.
„ <i>tetragona</i> , Poli.	<i>Macra elliptica</i> , Br.
(<i>A. papillosa</i> .)	„ <i>subtruncata</i> , Da Costa.
<i>Pectunculus glycymeris</i> , L.	„ <i>truncata</i> , Mont.
<i>Montacuta ferruginosa</i> , Mont.	<i>Syndesmya tenuis</i> , Mont.
(<i>Mya fer</i> .)	(<i>Tellemys t</i> .)
<i>Lasea rubra</i> , Mont.	<i>Pandora</i> ?
(<i>Anatina ovalis</i> .)	<i>Thracia papyracea</i> , Poli.
<i>Lucina borealis</i> , L.	<i>Corbula gibba</i> , Olivi.
<i>Cardium edule</i> , L.	<i>Mya Binghami</i> , Turton.

¹ It is likely that the land shells of Largo Bay are more recent than the marine fauna with which they are intermixed yet.

Panopea plicata, Mont.
Saxicava arctica, L.
Venerupis irus, L.
Chiton fascicularis, L.
 „ *marmoreus*, Fabr.
Patella vulgata, L.
 „ *cerulea*, L.
Helcion pellucidum, L.
 (*Patella* p.)
 „ var. *laevis*, Penn.
Tectura virginea, Müll.
 (*Patella* v.)
Fissurella græca, L.
Emarginula fissura, L.
Trochus cinerarius, L.
 „ *magus* ? L.
 „ *tumidus*, Mont.
 „ *umbilicatus*, Mont.
 „ *sizyphinus*, L.
Phasianella pullus, L.
 (*Turbo* p.)
Lacuna divaricata, Fabr.
 (*Turbo canalis*.)
 „ *pallidula*, Da Costa.
 „ *puleolus*, Turton.
Littorina jugosa, Mont.
 „ *littorea*, L.
 (*Turbo* l.)
 „ *neritoides*, L.
 „ *obtusata*, Gmel.
 „ *rudis*, Maton.
Rissoa cingillus, Mont.
 (*Turbo c.* and *Rissoa*
fallax.)
 „ *costata*, Ad.
 „ *costulata*, Ald.
 „ *crenulata*, Desm.
 (*Cingula cimeæ*.)
 „ *parva*, Da Costa.
 (*Cingula alba*.)
 „ var. *interrupta*, Ad.
 „ *punctura*, Mont.
 „ *reticulata*, Mont.
 „ *semistriata*, Mont.

Rissoa striata, Ad.
 (*Pyramis striata* and *P. discors*.)
 „ *zelandica*, Mont.
Barleeia rubra, Mont.
 (*Turbo unifasciatus*.)
Hydrobia ulva, Penn.
Turritella terebra, L.
Scalaria clathratula, Ad.
Ostomia acuta, Jeffr.
 „ *excavata*, Phil.
 „ *spiralis*, Mont.
 „ *turrita*, Hanl.
 „ *unidentata*, Mont.
Chemnitzia ladea, L.
Eulima polita, L.
Natica alderi, E. F.
 „ *catena*, Da Costa.
 (*N. glauca*.)
Adorbis subcarinatus, Mont.
Cerithium reticulatum, Da Costa.
Triforis adversum.
 (*Murex adversus*.)
 „ *perversum*, L.
Cerithiopsis tubercularis, Mont.
 (*Cerithium* t.)
Purpura lapillus, L.
Buccinum undatum, L.
Murex erinaceus, L.
Trophon muricatus, Mont.
 (*Murex m.*)
Nassa incrassata, Strom.
 (*Buccinum macula*.)
 „ *pygmæa*, Lamk.
 (*B. minima*.)
 „ *reticulata*, L.
Defrancia linearis, Mont.
 (*Murex* l.)
 „ *purpurea*, Mont.
Pleurotoma costata, Don.
 „ *rufa*, Mont.
 „ *septangularis*, Mont.
 (*Fusus* s.)
 „ *striolata*, Seacchi.
Cypræa europea, Mont.

Balanus porcatus.
B. balanoides.
B. communis.

Spirorbis granulatus.
S. nautiloides.
S. sinistrorsus.

Balanus crenatus.

Serpula vermicularis.

Verruca stromia.

Vermilia triquetra.

Cellaria fistulosa (*Salicornaria farciminoidea*), *Lepralia ventricosa.*

Echinus sphæra, *E. neglectus.*

Cancer pagurus.

Pisces. Vertebrae and teeth, or dermal scutes.

Caryophylla clavus, var. *Smithii.*

This deposit is, unfortunately, no longer accessible, being covered over by the road round the bay.

XXVII. *On the Viscera of a Female Chimpanzee.* By J. SYMINGTON, Esq., M.D., F.R.S.E., Lecturer on Anatomy, Minto House, Edinburgh; Examiner in Anatomy, University of Edinburgh.

(Read 19th February 1890.)

Through the kindness of our President, Dr Traquair, I have recently had the opportunity of dissecting a female chimpanzee, and I propose to lay before you some observations on the viscera of this animal. The literature dealing with the anatomy of the chimpanzee is pretty extensive, but it is mainly confined to an account of its osteology and myology or the configuration of its brain, the viscera generally receiving but scanty notice.

The animal I dissected was 2 feet 2½ inches in height, when measured from the top of the head to the heel. It had all its milk teeth and the first permanent molars. It was probably between three and four years old.

Brain.—This organ was injected through the carotids with spirit while the brain was still in the cranial cavity. This injection was repeated on several occasions, and on removing the calvaria, about ten days after the death of the animal, the brain was found to be pretty firm, so that it could easily be removed without much danger of any alteration in its shape. After its removal it weighed with the arachnoid and pia-mater, 13 ounces. It was kept in methylated spirit, and after being in this fluid for about eight

months, and having its membranes taken off, its weight was reduced to $8\frac{1}{2}$ ounces.

The weight of this brain is a little less than one described by Professor John Marshall,¹ as in the latter it weighed 15 ounces immediately after its removal from the cranial cavity and 9 ounces after hardening in spirit for several months. Professor Marshall's specimen was a male $1\frac{1}{2}$ inches taller than mine, but its dentition was not quite so advanced, as the upper first permanent molars had not erupted. My brain probably lost an ounce or so while in the cranial cavity by being injected with spirit, which would remove some of its water and dissolve some of its salts. Müller² gives a list of the weights of the brain in nine cases,—viz.: two by Owen, and one each by Marshall, Bischoff, Chapman, Parker, Drell, and himself. Of these specimens Marshall's is the heaviest and Müller's the lightest, the latter weighing only $9\frac{1}{2}$ ounces.

In Dr Chapman's³ case the brain weighed only 10 ounces and 10 grains, although his chimpanzee was fully as tall as Marshall's. In addition to the cases mentioned by Müller, other specimens have been described by Embleton and Bischoff, but they do not affect the general result, which may be stated as follows:—the average weight of the brain of a chimpanzee, with its milk teeth in position and its first permanent molars erupted, or about to do so, and its height between 2 feet and $2\frac{1}{2}$ feet, is probably not more than 12 or 13 ounces. We have unfortunately no account of the brain of the adult chimpanzee, all those hitherto described belonging to young individuals, which may be considered to correspond to children between two and four years of age. The brain of the latter is about three times heavier than that of the chimpanzee. Thus Boyd⁴ found the average

¹ On the Brain of a Young Chimpanzee—*Natural History Review*, vol. i., 1861.

² *Zur Anatomie des Chimpangehirn*—*Arch. für Anthropologie*, Bd. xvii., 1888.

³ On the Structure of the Chimpanzee—*Proceedings of the Acad. of Natural Science of Philadelphia*, 1879.

⁴ *Philosophical Transactions*, 1860.

weight of 29 children between two and four years of age to be 38·71 ounces.

Although we have no direct evidence as to the weight of the brain of the adult chimpanzee, we can form a very fair estimate by an examination of its cranial capacity. According to Topinard¹ this varied in three females from 387 c.c. to 425 c.c. Mr James Simpson, assistant in the Anatomical Museum of the Edinburgh University, very kindly measured the cranial capacity of my chimpanzee. He employed Sir Wm. Turner's method,² and found it to be 360 c.c. It thus appears that the increase in the cranial capacity of the chimpanzee is not very great after the commencement of the second dentition, and had my specimen lived until it was an adult, its brain would probably have weighed about 15 ounces. The average weight of the adult human female is about 44 ounces.

In my specimen the cerebrum completely overlapped and extended backwards about quarter of an inch behind the cerebellum. It is unnecessary that I should discuss this question, even although such recent writers as Chapman³ and Müller⁴ describe the posterior part of the cerebellum as being uncovered by the cerebrum, for D. J. Cunningham,⁵ by freezing the entire head and making sections of the brain *in situ*, has conclusively demonstrated that the cerebrum does completely overlap the cerebellum. In Müller's case the cerebellum is described as projecting 3 mm. beyond the cerebrum, but an examination of the drawings which he gives of the brain will readily show that he has unduly depressed the anterior part of this organ, and had he placed the brain in the skull with the face directed forwards, he would have found the cerebrum to reach farther back than the cerebellum.

The fissures and convolutions of the chimpanzee's cerebrum

¹ Anthropology, 1878, p. 50.

² "Challenger" Reports—Zoology, pt. xxix., p. 9.

³ On the Structure of the Chimpanzee—Proceedings of the Acad. of Natural Science of Philadelphia, 1879.

⁴ Zur Anatomie des Chimpansegehirn—Arch. für Anthropologie, Bd. xvii., 1888.

⁵ Royal Irish Academy—"Cunningham Memoirs," No. 2, 1886.

have been frequently described, but no apology is needed for referring to some of the principal features of my specimen, since authorities are by no means agreed on several points, and as the convolutions are undoubtedly subject to considerable variations, it is advisable that a number of cases should be put on record in order that the average or typical condition may be determined.

SYLVIAN FISSURE.—This fissure consists, as in the human subject, of a main stem, with two branches or limbs. The posterior limb is generally said to be more vertical than in man, and this appears to be the case. According to Broca,¹ the anterior limb of the sylvian fissure in man constantly divides into two branches, and in anthropoid apes this division often occurs. Bischoff,² on the other hand, holds that two branches are rarely met with. In my specimen, it is single, with a very faint trace of a forked arrangement at its extremity. Müller mentions a fissure placed in front of the anterior limb of the sylvian fissure, which is sometimes mistaken for it. On raising the temporo-sphenoidal lobe, the latter fissure will be found not to be continuous with the sylvian, but to end on the under surface of the frontal lobe. I find a fissure of this kind in my specimen. Through the kindness of Sir Wm. Turner I had the opportunity of examining along with him four chimpanzees' brains, which are in the Anatomical Museum of the University of Edinburgh. In all of them the anterior limb of the sylvian fissure was single and short. In some of them this was quite obvious, but in others it appears to be continuous with the fissure, already referred to as being in front of the sylvian. On raising the temporo-sphenoidal lobe, however, the two were found to be separated by a narrow bridging convolution.

FISSURE OF ROLANDO.—This fissure is very distinct in both hemispheres of my specimen. It begins close to the great longitudinal fissure, and runs downwards and forwards to end a little above the posterior limb of the sylvian fissure. In its course it is curved so as to form two anterior convexities of

¹ *Mémoires cerveau de l'homme et des primates*, Paris, 1888, p. 588.

² *Sitzbericht der München Akad.*, Feb. 1871.

about equal length. According to Professor Marshall, this fissure is situated farther forwards than in man. The two fissures form a V, and he describes the point of the V as being situated a little in *front* of the transverse axis of the hemispheres, whilst in man it is, to a still greater extent, *behind* that axis. Again he writes, "Suppose the whole length of the hemisphere to be represented by 100, then from the forepart of the brain to the point of the V would measure in the chimpanzee 49, and in man 57." Various other authors describe and figure the fissure of Rolando as being farther forwards than in man. The anterior part of the cerebrum, as compared with its posterior portion, is relatively narrower, and the orbital surface of the frontal lobes more deeply excavated than in man. These peculiarities of the chimpanzee's brain, with the forward position of the fissure of Rolando, are described as combining to render the frontal lobes relatively much smaller than in the human subject. Indeed, Marshall, in his paper already referred to, considers that "whereas nearly one-half of the upper surface of the cerebrum lies in front of the fissure of Rolando in man, a very little more than one-third is so placed in the chimpanzee" (p. 36). I have examined my own specimen, and find that it supports Marshall's views in respect of the diminished breadth and depth of the frontal lobes, but not with regard to its length as determined by the position of the fissure of Rolando. Of course, in measuring the position of this fissure in relation to the anterior and posterior extremities of the brain, it is necessary to decide how the brain is to be held. In my case the brain was kept in the cranial cavity, and the skull so placed that the orbits looked forwards. The position of the head nearly corresponded with that of the chimpanzee shown in mesial section in Plates 7 and 8 of Professor Cunningham's work.¹

Fig. 1 is a life-sized drawing of a vertical mesial section of my chimpanzee's brain. It shows the position in which it was placed in estimating the position of the fissure of Rolando. The X indicates the situation of the upper end of the fissure in relation to the anterior and posterior extremities of the

¹ Royal Irish Academy—"Cunningham Memoirs," No 2, 1886.

brain. Viewed from the *norma verticalis*, the total length of the cerebrum was 95 mm., and the distance from the anterior end of the brain to the upper extremity of the fissure was

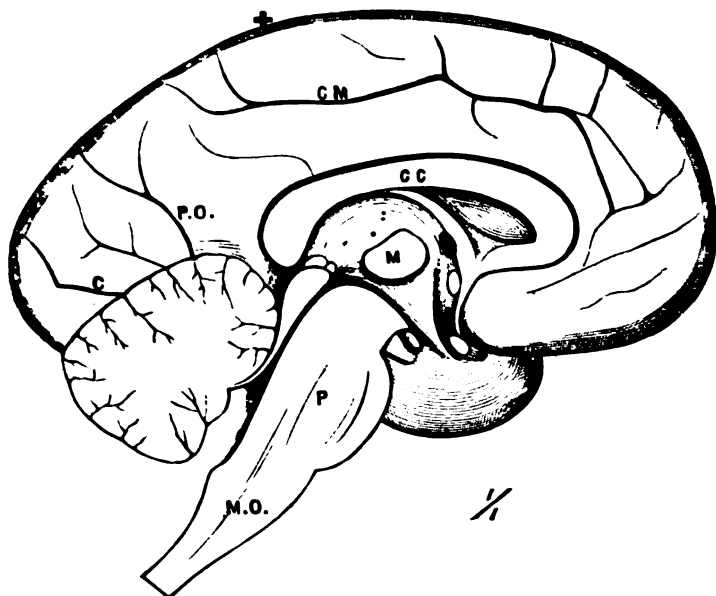


Fig. 1.

Left half of vertical mesial section of brain of chimpanzee. c. c., Corpus callosum. c. m., Calloso-marginal fissure. p. o., Parieto-occipital fissure. c., Calcarine fissure. p., Pons Varolii. m. o., Medulla. m., Middle commissure of third ventricle.

59 mm. Calculated according to the method adopted by Marshall, this gives an index of 62, showing the fissure to be even farther back than in man, in whom it is estimated at 57.

Gratiolet, in his "*Mémoire sur les plis cérébraux de l'homme et des primates*," has a view from above of the brain of a chimpanzee (*see* plate vi., fig. 1). I find that this agrees very closely with my own specimen in regard to the position of the fissure of Rolando, as it gives an index of 60°. It must be remembered that these indices are only approximate estimates of the position of the fissure as seen from above, since they are readily influenced by the position of the brain. Thus in my specimen a rotation of the brain round

a transverse axis, so as to depress the anterior part 10° , makes a difference of 5 in the index of the fissure, and so reduces it to that of man.

The fissure of Rolando passes outwards and forwards at about the same angle as in man, and I am of opinion that its position in relation to the anterior and posterior extremities of the brain is practically the same as it is in the human subject.

Parieto-Occipital Fissure.—The arrangement of this fissure in the chimpanzee has attracted the attention of numerous anatomists, more especially since the appearance of Gratiolet's classical "*Mémoire*," in which the first annectant convolution between the parietal and occipital lobes was described as being absent in the chimpanzee, although well marked in the orang. Further observations have not confirmed the view of Gratiolet, and various anatomists¹ have recorded cases in which the first annectant convolution was visible on the superficial aspect of the brain. Professor D. J. Cunningham² has recently described this convolution as constituting a distinct barrier to the communication between the internal perpendicular fissure as it turns outwards on the hemisphere and the intra-parietal fissure. Its relations in my specimen agree with Cunningham's statement. The internal part of the parieto-occipital fissure was separated from the calcarine by a superficial annectant convolution. This convolution appears to be very constant in the chimpanzee, although it is absent or very rudimentary in man.

The calcarine fissure gave rise to a large and prominent hippocampus minor in the posterior cornu of the lateral ventricle.

Alimentary Canal.—The tongue is relatively longer and narrower than in the human subject. In my specimen it was 3 inches in length and $1\frac{1}{4}$ inch in breadth. The circumvallate papillæ are described by Huxley³ as being disposed in the form of a T with the top turned forwards.

¹ Marshall, *Nat. History Review*, 1861, p. 211; Rolleston, *Ibid.*, 1861, p. 309; Turner, *Proc. Roy. Soc. Edin.*, vol. v., p. 578.

² *Jour. of Anat. and Phys.*, vol. xxiv., p. 149.

³ *Medical Times and Gazette*, vol. i., 1864, p. 487.

On the other hand, Chapman¹ and Cavanna² represent them as V-shaped. I examined them carefully in my specimen, as Bischoff³ refers to the question in connection with the determination of the nature of the animal called *Mafuca*, which died in the Zoological Gardens at Dresden, and about which opinions differed, some looking upon it as a chimpanzee and others as a gorilla. I found the papillæ arranged so as to resemble the letter Y rather than V or T. There were seven papillæ—three in the middle line forming the stem of the Y, and two on either side, representing its limbs. Bischoff found them collected into the form of a Y in *Mafuca*.

The soft palate was provided with a distinct uvula, and the tonsils were well developed. The stomach resembled that of the human subject in its shape and position. The small intestines were 11 feet long, and the large intestines 3 feet. Attempts have been made to show that the large intestines, as compared with the small intestines, are relatively longer in the chimpanzee than in man. Their relative lengths, however, vary so much in different specimens, that the question has no morphological significance. The cæcum and vermiform appendix were well developed—the former was 2½ inches in length, and the latter nearly 5 inches. On filling the large intestines with water from the rectum, it did not escape by ileo-cæcal opening into ileum even under the pressure of a column of water one foot high. There were no valvulæ conniventes in the small intestines, but Peyer's patches were very distinct. I counted about twenty, excluding a few very small ones. Their average size was about ⅔ of an inch in length, and about a ¼ of an inch in breadth. The villi were well developed, and could be distinctly recognised by the naked eye even in the ileum. The bile and pancreatic ducts opened by a common orifice into the second part of the duodenum. Solitary glands were abundant in the large intestines. There were no indications in the rectum of the transverse folds, such as are found in man.

¹ Proc. Acad. Nat. Science of Philadelphia, 1879.

² Archivio per l'antropologia, vol. ii., p. 211, 1875.

³ Mittheilungen der kgl. zool. Mus. zu Dresden, Heft 2.

The liver weighed 11 oz. Its main peculiarity, as compared with the human subject, was the large size of the caudate lobe. His has shown that in man it forms the superior boundary of the foramen of Winslow. It was the same here. This part of the lobe was small, and was placed between the structures joining the transverse fissure and the inferior vena cava. As the lobe passed towards the right side, it became considerably enlarged. When the liver was *in situ* this lobe was in contact with the right kidney, and did not project beyond the adjacent portions of the right lobe. Sir Richard Owen¹ states that "fissures rather than lobes are added to the livers of quadrupeds," and this seems to be frequently the case. Portions of the liver which seem to be very prominent when that organ is removed from the body, do not project beyond the general surface of the liver when it is in its natural position in the abdomen. The gall bladder was large and slightly folded near the fundus. The right kidney weighed $1\frac{1}{2}$ oz., and the left $1\frac{3}{4}$ oz. The malpighian pyramids were blended together, and formed a common ridge, which projected into the undivided pelvis of the ureter.

The spleen had three surfaces—gastric, splenic, and renal. There were no notches in its anterior border. Its weight was $1\frac{3}{4}$ oz.

The only peculiarity of the superior aperture of the larynx was the absence of the cuneiform cartilages in the aryteno-epiglottidean folds. The true and false vocal cords closely resembled those of the human subject. On passing a probe into the saccule, this recess was found to extend upwards above the level of the aryteno-epiglottidean folds as high as the lower part of the tonsil. In man the saccule seldom extends as high as the aryteno-epiglottidean folds. On the left side the saccule communicated with a bursa in front of the thyro-hyoid membrane. This bursa was not much larger than it is in the human subject. The thyroid gland was rather small. It consisted of two lateral lobes and an isthmus. The latter has been described by Bischoff as absent.

¹ *Anatomy of Vertebrates*, vol. iii., p. 483.

The right lung was divided into three lobes, and the left into two.

The heart and great vessels presented no special peculiarities. The annulus ovalis was feebly marked, and the moderator band in the right ventricle was represented by several bundles of fibres. The innominate and left common carotid arteries arose by a common trunk, otherwise the arrangement of the large vessels was the same as in the human subject.

The inferior mesenteric vein joined the splenic about half an inch from its termination. According to Mr Treves¹ this is a feature in the higher development of animals, as in none below monkeys does it end in this way.

Female Genitals.—Our knowledge of the anatomy of the female genitals in the chimpanzee and the other anthropoid apes is very imperfect, and the few descriptions we have of these organs differ on several points.

The following account is based upon the examination of the pelvic viscera of two animals—viz., the one described in the previous portion of this paper, and another for which I am indebted to the kindness of Professor D. J. Cunningham. The former specimen I received, as already mentioned, in a fresh condition. The genitals were examined *in situ*, and then removed for further dissection. The specimen I received from Dr Cunningham consisted of the pelvis and lower extremities of a female chimpanzee, which was somewhat younger than the one I had previously examined. The pelvic viscera had not been removed. I decided to make a mesial section of this pelvis, and this was done with a large knife after the specimen had been well hardened in spirit. Fig. 2 represents the left half of this section. While readily admitting that this method is not so satisfactory as that of making frozen sections of the entire animal, I believe that the drawing illustrates very accurately the normal relations of the structures at the lower part of the pelvis. It certainly agrees very closely with the results obtained by an examination of the entire animal. It must be remembered that both my specimens were young and sexually immature.

¹ The Anatomy of the Intestinal Canal and Peritoneum in Man, 1885, p. 15.

The special accumulation of fat, known as the mons Veneris, which is found in the human subject in front of the pubes, is generally said to be absent in the anthropoids. It

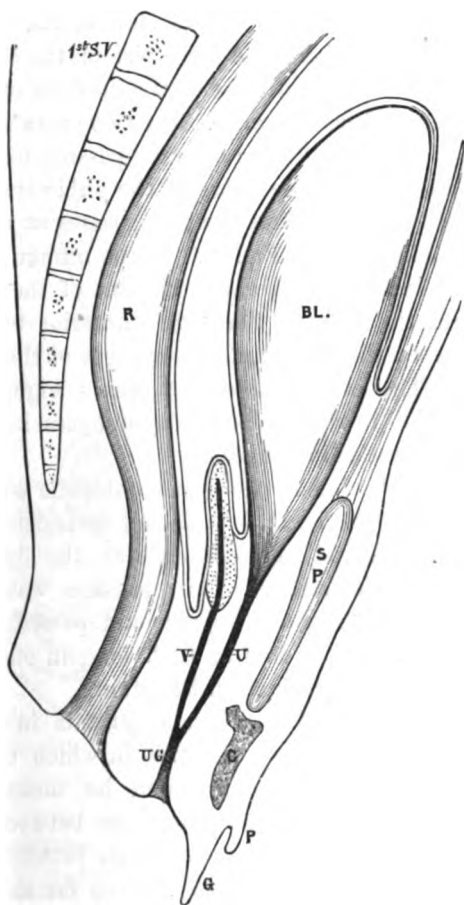


Fig. 2.

Left half of a vertical mesial section of pelvis of female chimpanzee about two years old (life size). s. v., 1st sacral vertebra. s. p., Pubic symphysis. R., Rectum. BL., Bladder. v., Vagina. u., Urethra. uo., Uro-genital canal. c., Clitoris. p., Prepuce. g., Glans clitoridia.

is quite true that the amount of fat in this position is very much less in the chimpanzee than in man; at the same time

it is worthy of note that the mesial section of the chimpanzee's pelvis showed that the layer of subcutaneous fat in front of the pelvis was about three times as thick as that on the anterior abdominal wall. The labia majora are rudimentary, and do not conceal the labia minora and clitoris. All authorities agree in recognising the large size of the clitoris; but there is a point in connection with the position of this organ to which I can find no reference. The two crura are attached to the sides of the pubic arch, and, passing forwards and upwards, unite at the lower edge of the pubic symphyses to form the body of the clitoris, which passes at once downwards and backwards (*see* Fig. 2). In the human subject the two crura are prolonged upwards in front of the pubis, and unite to form the body of the clitoris anterior to and about midway between the upper and lower edges of the symphyses (*see* Fig. 3). The clitoris thus occupies a higher and more anterior position in relation to the symphyses in the human female than in the chimpanzee.

In both my specimens the glans clitoridis was flattened from before backwards, and projected considerably beyond the prepuce. Behind the clitoris was the opening of a distinct uro-genital canal. This passage was connected above with the urethra and vagina, and passed downwards and backwards. It was half an inch long in one specimen, and three-quarters of an inch in the other.

Bischoff¹ stated that the female genitals in the human subject presented numerous features in which they differed from those of the anthropoids, and he maintained that Huxley's proposition that the differences between man and the anthropoid apes were less than those between the latter and the lower monkeys was not true so far as the female genitals were concerned.

There can be no question but that the differences between the relations of the external genitals in the chimpanzee and in the human subject are very marked. This is very evident

¹ "Vergleichend anatomische Untersuchungen über die äusseren weiblichen Geschlechts- und Begattungsorgane des Menschen und der Affen, insbesondere der Anthropoiden"—Abh. der könig. bay. Akad. der Wissenschaften, Bd. xiii., 11 Abth., p. 207.

from an examination of Figs. 2 and 3, representing mesial section of their respective pelvises. That of the human subject is from an adult, but, so far as the points under consideration are concerned, it would do equally well for a young child.

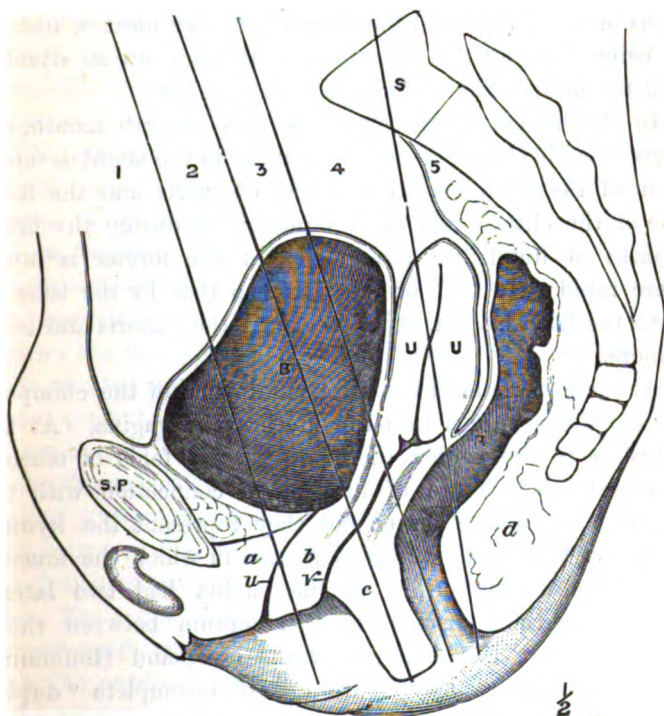


Fig. 3.

s. p., Symphysis pubis. s., First piece of sacrum. B., Bladder. R., Rectum.
u., Urethra. v., Vagina. u. u., Uterus.

In the human subject the external genitals show a longitudinal cleft passing from just below the mons Veneris backwards as far as the mass of tissue lying in front of the anus. The sides of this cleft are bounded by the labia majora, and it is not until these are separated that the relatively small labia minora and clitoris can be seen. The urethra and vagina pass downwards and forwards, making with the horizon an angle of about 60°. Below they open

into the vulval cleft. When the subject is in the erect position the glans clitoridis and the external orifice of the urethra are in about the same horizontal plane.

In the chimpanzee the mons Veneris and labia majora are very rudimentary, and the large clitoris and labia minora are visible without any manipulation of the parts. Again, the glans of the clitoris and the external urinary meatus, instead of being in about the same horizontal plane, are so situated that the meatus lies vertically above the glans.

In the human foetus before the fifth or sixth month, the parts resemble those of the chimpanzee in the slight development of the labia majora and mons Veneris and the large size of the clitoris and labia minora; but during the latter months of foetal life the growth of the former is much more rapid than that of the latter, so that by the time of birth the labia majora usually conceal the clitoris and labia minora.

At the upper end of the uro-genital canal of the chimpanzee are the openings into the urethra and vagina. At the entrance to the vagina there are several folds of mucous membrane, which are of interest in connection with the question as to whether or not they represent the hymen. Dr G. v. Hoffmann¹ recorded a case in which the mucous membrane at the orifice of the vagina had two lateral openings with a distinct median septum between them. This, however, is not normally the case, and Hoffmann's specimen was obviously an example of incomplete "duplex vagina." Bischoff,² while admitting the existence of certain folds of the mucous membrane at the vaginal orifice, describes the hymen as absent.

In the animal I obtained from Dr Traquair there were four folds of the mucous membrane—two on each side. These folds—which in shape resembled somewhat the aortic semi-lunar valves—had their free edges directed downwards, and they were bounded externally by recesses, 3 or 4 mm.

¹ Über die weiblichen Genitalien eines Chimpansen"—Zeitschrift für Geburtshilfe und Gynäkologie, 1878.

² Untersuchungen der Eingeweide und des Gehirns des Chimpansee-Weibchen—Mittheilungen des Kgl. Zool. Museum zu Dresden, Heft 2.

deep, which would admit a No. 9 catheter. Into the posterior pouch on each side opened a duct just admitting a hog's bristle. The duct could be traced upwards at the side of the vagina nearly as high as the external os uteri. Here it became connected with a small mass of glandular tissue, which obviously represented the gland of Bartholin or Duvernoy. In my other specimen there were only two recesses, one on each side; but on opening them up they were found to be imperfectly divided into two compartments. Although generally overlooked or imperfectly described, similar recesses will generally be found in the human subject. These pouches are situated just external to the hymen. They are usually well marked in the foetus, but will be found to vary a little in their number and depth. In one nine-months' foetus I found four recesses, the posterior pair receiving the ducts of Duvernoy's glands. These recesses are not usually quite so distinct in the adult, but those situated anteriorly near the urethral orifice are almost always present, and may be mistaken for that opening. The human hymen is evidently the homologue of the folds found at the vaginal orifice in the chimpanzee, these folds having blended to form a continuous membrane. In the specimen represented in Fig. 2 there was an example of a tendency to this fusion, since there were only two folds, one on either side. The vagina was directed downwards and backwards. It was nearly twice the length of the uro-genital canal. Both the anterior and posterior walls had a few faint folds of the mucous membrane, but there were no distinct columns or rugæ. The uterus resembled very closely that of a young child. The cervix was thicker and firmer than that of the body. On opening into the cavity of the uterus, the folds of its mucous membrane were seen to reach to the top of the uterus. The only peculiarity in these folds was that the longitudinal ones were rather better marked, and the transverse ones less distinct than in the child. The length of the uterus was $\frac{3}{4}$ of an inch in one specimen, and $\frac{1}{4}$ of an inch in the other.

In the human subject the uterus retains its infantile form and size until near puberty, when it begins to grow rapidly,

more especially in the parts corresponding to the body and fundus. Such appears to be also the case in the chimpanzee. Thus Wyman¹ found the uterus of an adult chimpanzee to be $2\frac{1}{2}$ inches long, while my specimen, which had cut its first permanent molars, had a uterus less than an inch in length, and the general relation of its parts were purely infantile in their character.

The ovaries and Fallopian tubes presented no peculiarity worthy of notice.

Some of the special features of the female genitals of the chimpanzee, such as the large size of the clitoris, the prominence of the labia minora, and the direction of the urethra and vagina, will be found to some extent in the human foetus. Even, however, by the fourth or fifth month the lower parts of the vagina and urethra will be found to be directed somewhat forwards as well as downwards, and before birth the clitoris and nymphæ have acquired their adult relations to the labia majora. A few months after birth, the direction of the vagina is practically the same as in the adult. On the other hand, from a cursory inspection of the external genitals of the adult female chimpanzee "Sally" in the Zoological Gardens of London, I am inclined to believe that the relation of the structures at the pelvic outlet represented in Fig. 2 will be found to persist in the adult.

There can be little doubt as to the correctness of the opinion of Blumenbach and Cuvier that the anthropoid apes copulate *a posteriori*. Quite a number of peculiarities in the anatomy of the chimpanzee, as compared with the human subject, exist, which must facilitate copulation *a posteriori*, or obstruct its performance *ab anteriori*. These peculiarities in the chimpanzee are the marked obliquity of the pelvis, the feeble development of the buttocks, the rudimentary condition of the mons Veneris, the large size and the position of the clitoris, and the direction of the vulvo-vaginal and vaginal canals.

¹ Boston Journal of Natural History, vol. iv., p. 380.

XXVIII. Notes on a Small Collection of Fresh-Water Ostracoda from the Edinburgh District. By THOMAS SCOTT, F.L.S., Naturalist to the Fishery Board for Scotland.

(Read 22d January 1890.)

This collection of Ostracoda comprises type-slides of species from nine different localities, as follow :—

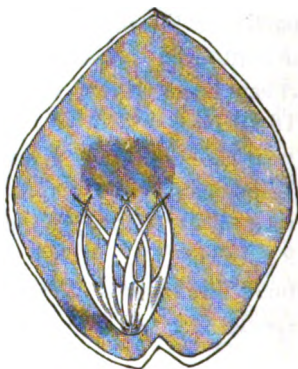
1. Duddingston Loch, 3 slides containing 22 species.
2. Pond near Corstorphine Hill (north side), 1 slide containing 5 species.
3. Kinghorn Loch, Fifeshire, 1 slide containing 10 species.
4. Loch Fitty, Fifeshire, 2 slides containing 18 species.
5. Loch Glow, partly in Fifeshire and partly in Kinross-shire, 1 slide containing 9 species.
6. Black Loch (near Loch Glow), Kinross-shire, 2 slides containing 16 species.
7. Lurg Loch (near Loch Glow), Kinross-shire, 1 slide containing 7 species.
8. Dow Loch (near Loch Glow), Kinross-shire, 1 slide containing 9 species.
9. Pools at Luffness Links near Aberlady, 2 slides containing 13 species.

As might be expected, a number of the species from the various localities named are more or less common to all of them, as well as being generally distributed throughout these islands, such as for example *Cypria ophthalmica*, *Cypria serena*, *Erpetocypris reptans*, *Cypridopsis vidua*, *Candona candida*, and some others. It is not necessary, therefore, that these should be referred to in the following notes, more especially as I am preparing lists, intended to be more or less inclusive, of this and other groups of the Entomostraca observed in the district around Edinburgh to be submitted to the Royal Physical Society later on; consequently I will at present confine my remarks to those which are as yet considered rare, or have not hitherto been recorded from any locality near Edinburgh.

By referring to the localities represented in this collection,

it will be observed that Duddingston Loch has as yet yielded the greatest number of species, viz., 22, exclusive of a *Candonæ* which differs somewhat from any previously described; it comes nearest *Candonæ rostrata*, Brady and Norman, but is decidedly more tumid than that form, and so for the present it is set aside as doubtful.

While examining some specimens of this tumid form, I noticed alongside one of the animals an object that I at first thought might have some connection with the sexual organs. I mounted the specimen with the object *in situ* and sent it to Dr Brady, but he could not say what it was. Possibly it is a parasite of some kind, and may, partly, be



Parasite (?) observed in one of the tumid *Candonæ* from Duddingston ;
greatly enlarged.

the cause of the more tumid form of the *Candonæ* referred to. It is obscurely rhomboidal in outline, the base is truncate and deeply notched; internally and springing from one side of and a little above the base are six elongated, curved teeth, having their lower part much broadened inwards, three of them being curved inwards and three curved outwards. My son suggests that it may be the cestocercal stage of a species of *Cestoda*, whose ultimate development is reached in some fresh-water fish, as the trout or stickleback that preys on Entomostraca.

Cyprois flava (Zaddach), from Duddingston Loch, is an interesting species because of its very restricted distribution.

At present it is not known to occur in any other locality in the British Islands, unless the *Cypris gibbosa* recorded by Dr Baird from a ditch in Surrey more than fifty years ago be the same species. I have obtained it in considerable abundance in one particular part of the loch. Comparatively it is a moderately large Ostracod, of a yellowish colour. It is much compressed laterally, but has the dorsal margin prominently arched.

Erpetocypris olivacea, Brady and Norman, from Duddingston Loch, is as yet a comparatively rare species, though in localities where it does occur it may be fairly plentiful. Till lately Duddingston Loch was the only Scotch locality where it had been observed. I am now able to exhibit specimens from Kinghorn Loch, Fifeshire, and from Black Loch, Kinross-shire.

Erpetocypris tumefacta (Brady and Robertson). This species, which does not appear to have previously been recorded from anywhere near Edinburgh, is exhibited in this collection from Duddingston Loch, pools at Luffness Links, Loch Fitty (Fifeshire), and Black Loch (Kinross-shire), and is of frequent occurrence in all these localities.

Candona rostrata, Brady and Norman, not previously recorded from the Edinburgh district, has been obtained from Duddingston Loch, Loch Fitty (Fifeshire), Lurg Loch and Black Loch (Kinross-shire). It seems to me that this will ultimately be found to be a generally distributed species.

Cypris pubera, O. F. Müller. I obtained this fine species at Kinghorn Loch in considerable abundance. I have also seen specimens from Kilconquhar Loch, near Largo. It has been previously recorded from Duddingston Loch (a young specimen from this loch is also on one of the slides exhibited), the Town Loch near Dunfermline, and Linlithgow Loch. Its distribution in Scotland seems to be confined to the middle and eastern counties, but perhaps when the invertebrate fauna of these islands becomes more thoroughly worked up, *C. pubera* may be found to have a wider range.

Cyclocypris globosa (G. O. Sars) was one of the more common species in Loch Fitty, Fifeshire; it was also of

frequent occurrence in Loch Dow and in Black Loch, Kinross-shire. This is the first record of it from both of these counties.

Notodromas monacha (Müller) was also common in Loch Fitty and in pools at Luffness Links. This species does not appear to have been previously recorded for the east of Scotland; it is easily distinguished by its peculiar form and colour (being black, or nearly so).

Candona acuminata (Fischer). Loch Fitty is the only one of the nine localities here represented where this *Candona* was obtained, though I have it from other districts. It is one of the rarer British species, and has been observed in only a few places in Scotland.

? *Candona hyalina*, Brady and Robertson. A *Candona* which seems to belong to the species named was of frequent occurrence in Loch Fitty; it was also obtained, though not common, in Lurg Loch and Dow Loch. I found by dissecting the animal that it differed especially in the length of the joints of the antennules and antennæ from either *C. kingslei* or *C. fabæformis*; the form of the shell also differs from both these species. The dorsal margin slopes upward similarly from each end, and forms a distinct central ridge. All the specimens examined were females. Though only the east end of Loch Fitty was searched, no fewer than eighteen species of Ostracoda were obtained.

Cypris obliqua, Brady. This is a rare species in Scotland, and hitherto appears to have been observed in only four localities, viz., Lewis, Isle of Skye, Bute, and Cumbrae, which are all on the west coast. I am now able to add two, though closely adjoining, localities toward the east coast for this *Cypris*—Dow Loch and Lurg Loch in Kinross-shire. It is a very neat and distinct species. The colour of the specimens for these two lochs is a rich chocolate-brown, similar to those recorded by Mr Robertson of Millport from the Isle of Man, while those from a lochan or tarn on the hillside above Millport, Cumbrae, are bright green.

Candona euplectella, Robertson. A reference to this species, which when clean and in good form excels in beauty all other European Ostracoda, will conclude my remarks on the

collection now exhibited. This appropriately named, and delicately beautiful species was discovered by Mr Robertson a good many years ago in Callum's Tarn, Bute. It has since been observed in several other places in the west and south of Scotland, but hitherto it does not appear to have been recorded from any locality on the east side. It is with some pleasure therefore that I now report its occurrence in the Dow Loch, Kinross-shire, where several specimens were obtained by me last summer when examining the lochs among the Cleish Hills, of which the Dow Loch is one. So far as I know this species has not as yet been observed outside of Scotland.

XXIX. *The Cubital Coverts of the Euornithæ in Relation to Taxonomy.* By J. G. GOODCHILD, H.M. Geol. Survey, F.Z.S., M.B.O.U. [Plate XV.]

(Read 19th February 1890.)

The birds of the present day well illustrate a class of animals that have attained the heyday of their development. They present, in consequence, an extraordinary number of species, whose extremes of structural modification differ from each other to hardly a greater extent than do even those of certain genera amongst the lower forms of the Sauropsida. Indeed, after the taxonomist has placed on one side the Struthious birds, and on the other the Penguins; the remainder, or the Euornithæ, consist of many thousands of forms, which are connected with each other by structural ties of the most intimate nature. Even in the case of those birds whose external characteristics differ noticeably from the rest, closer examination reveals the existence of complex inter-relationships and cross ties, which clearly indicate that the Euornithæ form one great natural group, as yet very little broken up into isolated sections through the extinction of annectant forms. The relationships of the Euornithæ might therefore be represented by a complex net-work, which no amount of ingenuity can ever force, satisfactorily, into a linear arrangement.

The older taxonomists certainly proceeded on wrong principles in their attempts at the classification of birds; as, in nearly every case, as they selected, as the basis for their systems, just those structural characters that are directly and intimately connected with the well-being of the species as it stands at the present day. In other words, they employed as a basis for classification the characters that have been the *latest* to be acquired, and that are, in consequence, most likely to undergo rapid changes as the species adapts itself to changes in its environment. Some of these same characteristics have almost certainly been independently evolved by more than one group, simply because they happened to meet their respective requirements.

A zoological classification, to be really natural, must be an expression of the genetic history of the animals under notice—the higher grades corresponding to the modification dating farthest back in the history of the group, and the lower grades coinciding with the differentiations of later date. Such an ideal classification, at least in the case specially under consideration, is as yet unattainable. All we can do at present is to review every possible feature connected with birds, and to assign, generally, a low taxonomic value to those characters that are directly connected with the present welfare of the species, or the genus, as the case may be, and to give a higher rank to any and every feature that is clearly a vestige of a past condition, and has long been, so to speak, *hors de combat*, so far as the struggle for existence is concerned. It is such characters as these that may be expected to retain archaic characteristics, and will be, therefore, of value in working out a classification of birds based upon their genetic history. Under this category should be classed the history of the development of the individuals: osteological peculiarities, such as those afforded by the character of the palate, of the sternum, or of the nasal bones; myological facts, such as the presence or the absence of the ambiens muscle, etc.; visceral, as in the case of the ovum, etc.; dermal, as in the distribution of the feather tracts, or the nature of the oil-gland. Such features, again, as the relative precocity of the chicks, upon

which Mr Seebohm lays so much stress, or upon the number of eggs laid, must also come under the same category. To these must be added the grouping based upon the presence, or the absence, of the fifth cubital remex, which Messrs Gerbe, Wray, Gadow, Sclater, and others have described in detail.

To these I may now venture to add, the disposition of the Cubital Coverts, which formed the subject of a paper read before the Zoological Society of London, and published in the *Proc. Zool. Soc.* for April 1886. In this communication I contented myself with summarising a series of observations extending over the previous sixteen years, the result of the detailed examination of many thousands of specimens—alive, in the flesh, or as cabinet specimens. The facts and the arguments based upon them were quite new; for although Nitzsch had, as I found after the paper was printed, noticed a certain amount of variation in the particular feature under notice, yet neither I, nor any zoologist with whose opinion I am in the least acquainted, was aware of the fact. Indeed, in the abstract of Nitzsch's paper, which was given many years ago in the *Proc. Zool. Soc.*, no mention whatever was made of the features specially under notice. Nor does it seem to have been observed either by Professor Flower or by his able coadjutor Mr Wray while they were working out the subject in connection with the beautiful series of preparations in the Index Collection at the Natural History Museum.

Mr Wray communicated a very valuable paper on the wings of birds, about a year after mine was published, and in this paper a nomenclature much superior to the one I had previously used was employed. In the present paper, therefore, I adopt, generally, and with some slight modifications, the nomenclature referred to. Some of his facts and opinions have also been embodied. In the present paper I shall attempt to review the subject generally, so as to be able to apply the conclusions to a scheme of classification based exclusively upon the disposition of the Cubital Coverts. This, of course, is proposed merely as a tentative scheme, and is advanced solely with a view to calling attention to the importance of this feature as a new factor, which hereafter

may be employed in its proper place amongst other data used for classification. I take advantage of the present opportunity also, to incorporate many new observations, as well as to make some emendations to my former paper suggested by a wider knowledge of the facts.

The general conclusions may be conveniently stated at this point. They are that a particular style of overlap or imbrication of the several feathers in each row of the external Cubital Coverts, and a particular number of feathers in each row, are absolutely constant for all the individuals of the same species, for all the species of the same genus, and even for all the genera in the same family or even order as this last is understood by ornithologists in general. For example, over five thousand species of *Passeres*, embracing the whole of the *Acromyodi*, and nearly all the *Mesomyodi*, exhibit absolutely the same general style of wing coverts. This style is not only uniform throughout the entire group, but is absolutely characteristic of it, as it is not found in any group of birds outside the commonly-accepted limits of the *Passeres*. A glance at the wing of a bird will therefore enable one to pronounce at once whether it belongs to a *Passerine* bird or not. What is true of the *Passeres* applies also with more or less truth to other groups of birds: each group being characterised by its own special pattern. The exceptions, so far as I have observed them, will be separately noticed; and it will be seen, in most cases, that it is more than likely that these exceptions are more apparent than real, and that they are more likely than not to be due to the birds in question having been wrongly placed in the systems most in vogue.

As a type Professor Flower has chosen the Wild Duck. This is excellent of its kind; but, having regard to all the observed variations, the wing of the Golden Plover is by far the better type (see Fig. 18). From this wing, by successive slight modifications in different directions, every style of wing coverts observed in the *Euornithæ* may be reached by easy gradations. But, as Mr Wray has taken as his type the wing of the Wild Duck, I have added a drawing of it (Fig. 14), which has been carefully drawn, and has been repeatedly compared with other examples belonging to the same

species. Mr Wray's figure is not quite correct in some minor details.

Tracing the feathers of the outer surface of the cubital region of the wing from behind forwards, they succeed each other as follows:—(1) the Cubital Remiges, (2) the Major Coverts, (3) the Inframedials (or the "Supplementary Row of Median Wing Coverts" of my former paper), (4) the Medials, (5) the Minor Coverts, and (6) the Marginals. It may be at once stated that the Cubital Remiges and the Major Coverts next above them are invariably imbricated in such a manner that they overlap *distally*, or so that the outer margin of each feather lies above the inner margin of the one next removed from the vertebral axis. The reverse order of overlap I termed *proximal*. These terms have been generally adopted by American and other writers since.

The principal seat of variation on the wing is the area covered by the Inframedians, the Medians, and the Minors—the variation consisting (1) in the number of rows, and also of the number of feathers in each row; and (2) in the direction of imbrication of the several feathers, whether *distal* or *proximal*. The outline figures accompanying this paper will serve to make the nature of the difference in each case much clearer than could be done by many pages of description. In a few cases I have been unable to distinguish satisfactorily between the Marginals and the Minors. This is especially the case with the Pigeons, which present a very abnormal style of wing coverts, and one so complicated as almost to baffle description.

I. THE CYPSELINÉ STYLE.—The simplest style of wing coverts is found in the Humming Birds (Fig. 1). In these birds, as I interpret the evidence, the cubital feathers are (1) the Remiges, (2) the Major Coverts, and (6) the Marginals. Both the Medians and the Minors appear to be entirely unrepresented.

It is not a little remarkable, and is also significant, that the birds whose wing style agrees most closely with the Humming Bird are the Swifts (Fig. 2). In the Swifts there is a slight approach to the Passerine style; but, judging by this feature alone, those taxonomists are right who class the

Humming Birds and the Swifts together in one suborder. The CYPSELIFORMES, then, present a different style of wing coverts from the parallel groups amongst the PASSERES—the Sunbirds and the Swallows (see Fig. 2a). The difference in style can hardly be attributed in these cases to difference in mode of life. Rather does it appear to me to represent an archaic feature, dating back to the remote past, when these now-useless morphological characters served some real purpose in the economy of the possessors.

Two other groups of birds possess much the same simple style of wing coverts as the CYPSELIFORMES. These are (1) the Birds of Paradise (Fig. 3), and (2) the Trogons. In the PARADISIDÆ every individual I have examined showed the whole of the feathers above the Major Coverts lying with *distal* overlap, and with, generally, much the same arrangement as in the CYPSELIFORMES. The number of rows, however, is considerably increased in the group under notice.

II. The PASSERINE STYLE.—The next advance in complexity is represented by the great group of the PASSERES proper. These generally possess, in addition to the Marginals seen in the CYPSELIFORMES, *one* row of Minor Coverts, with *distal* overlap, see figure of Skylark (Fig. 4), and one row of Medians, whose overlap is generally *proximal* throughout nearly the whole of this large group. The CORVIDÆ (see Fig. 5) differ slightly from the normal type, inasmuch as a few of their anterior Medians overlap distally. In this respect they make an approach, superficially, to the PARADISIDÆ, as they are commonly believed to do in some other respects.

It may be said, therefore, in general terms, that almost the whole of the birds with an ægithognathous palate, with cœca, with a nude oil-gland, with the fifth cubital remex present, devoid of the *ambiens* muscle, and whose young are hatched helpless and naked, have simply the ordinary rows of Marginals, one row of Minor Coverts, whose edges invariably overlap distally (which are not present in every group), and with one row of Medians, whose overlap is proximal in every case.

Some exceptions to the general rule have already been

alluded to. It is significant that these should be limited to the *Mesomyodi*, a group of aberrant Passeres commonly regarded as representing annectant forms between the Passeres proper and the true Picarian birds, to be noticed presently. The birds referred to are the COTINGIDÆ, the Bower Birds (*Ptilorhynchus* and *Chlamydodera*), and, possibly also, the EURYLÆMIDÆ. In these more than one row of Minor Coverts occur, each with proximal overlap. As this is the special characteristic of the Picarians, it is just possible that subsequent research may prove that the birds in question rightly belong to that section, and are not Passerine birds at all.¹

III. The CUCULINE STYLE.—Two lines of modification are traceable from the Passeres. One of these passes through the CUCULIDÆ and the CAPRIMULGIDÆ. In these the number of feather rows is greater than occurs in the Passerine birds; and the distinction of the Minors from the Marginals cannot be satisfactorily made out. In one section of those there is present a group of five or six feathers projecting beyond the rest of the median coverts, and answering to what I have elsewhere called the Inframedials. For the present, Figs. 6 and 11 must suffice to represent this style. We shall need to return to these sections later on.

IV. The PICARIAN STYLE.—A very simple advance upon the Passerine type is presented by the Picarians. In these, as the figure of the *Gecinus viridis* will show (Fig. 7), the difference lies in the increased number of rows of coverts between the Marginals and the Majors. Of these, the single row of Medians, as well as the Minors, which occur usually in not less than two rows, overlap *proximally* and *without any interruption* or "faulting" whatever. This style characterises the whole of the PICI, as well as the Aniso-dactylous Picarians, with the exception of the STEATORNITHIDÆ, the PODARGIDÆ, and possibly the BUCEROTIDÆ. It is particularly well displayed by the Kingfishers, the Toucans, and the Woodpeckers (Fig. 7).

¹ Since this was printed Mr Eagle Clark has shown me a specimen of *Irisor*, which is sometimes classed with the Picarians. This bird has an unmistakable Passerine wing style; so that those are probably right who place this genus near *Sturnus*.

V. The GALLINE STYLE.—The succeeding modification is represented by the normal Gallinaceous birds. In these the number of rows between the Marginals and the Majors is usually greater than in the Picarians; so that the wing coverts occupy a still larger proportion of the cubital area. The Medians and the Minors overlap proximally throughout nearly their entire extent in the MELLAGRIDÆ (Fig. 8), which in this respect stand alone amongst the Gallinaceous birds. In the remaining groups the inner or proximal third, or more, of each row of Minors, as well as the Medians, overlap distally. In the closed wing of the living birds this arrangement makes the whole of the visible wing coverts appear to have a distal overlap. In the whole of the Gallinaceous birds I have examined there is no trace whatever of any break, interruption, or "faulting" of the coverts. The Peristeropods (*Talegalla*, *Crax*, etc.) have a simpler style of wing coverts than the Alectoropods (*Gallus*, *Tetrao*, etc.); and in many respects approach the confines of the group next to be described. See figure of *Crax* (Fig. 9) and of *Phasianus* (Fig. 10).

The wing style of the Tinamous (CRYPTURI) differs in no essential respect, I have observed, from that of the Gallinæ. The same observation applies also to the HEMIPODII.

VI. The ACCIPTRINE STYLE.—In all the birds previously noticed (except the Goatsuckers in Group III.) the typical number of the Cubital Remiges is present. In those now to be considered most of the genera agree with each other in the particular that the fifth cubital remex is absent. This remarkable feature was first noticed by M. Gerbe, and has since been further investigated by the late Mr Wray, Prof. Flower, Dr Gadow, Dr Sclater, and others. At the time my paper in the *Proc. Zool. Soc.* was read, I was unaware of the curious fact referred to, and, in consequence, I failed to perceive the true significance of the feature next to be described, although I had described some of the phenomena resulting from it, in detail. Notwithstanding that the fifth cubital remex is wanting in the group now under notice, its corresponding covert is invariably present. The reason of so anomalous an arrangement is difficult even to guess at.

But although that particular feature had now been noticed repeatedly in the course of dissection, it does not seem to have occurred to any one that any *external* and easily-examined evidence of the presence or the absence of the fifth cubital remex could be traced. Yet so it is. In the original paper dealing with the cubital coverts of birds I laid great stress upon the fact that all the Euornithæ might be divided into two sections according to whether they did, or did not, possess what I then termed the "Supplementary row of Median Coverts, or Upper Wing Coverts." I pointed out that the possession of the feature referred to coincided with that of several structural characteristics of considerable importance (*op. cit.*, p. 191). Since Mr Wray's paper has been published it occurred to me that there might be some connection between the curious break in the arrangement of the wing coverts, and the presence or the absence of the fifth cubital remex. This has proved to be correct in so many cases that I shall assume it to be true for all. An examination of a large number of aquincubital wings showed clearly that, from the point where the fifth cubital remex is missing, up to the margin of the wing above, there is a marked disturbance of position of all the coverts. In the case of the homalogonathous¹ birds with the desmognathous² type of palate, the displacement takes the form of a down-throw on the side next the outer margin of the wing. The wing coverts, in fact, are what geologists would describe as "faulted," and the course of the "fault" can be distinctly traced by the disturbance of the coverts it causes right across the wing. The Major coverts are generally displaced less than the Medials, but there can be no doubt about the fact. (See the figure of the Duck (Fig. 14), the Pigeon (Fig. 17), and the Tern (Fig. 20) as illustrations of this displacement.) In certain birds, to be noticed in more detail presently, the line of displacement coincides with a change of direction of overlap, usually from proximal to distal. This external mark of aquincubitalism was made known for the first time on the evening when the second instalment of this paper

¹ See Garrod, Proc. Zool. Soc., 1874, No. viii., p. 116.

² See Huxley, Proc. Zool. Soc., 1867, No. xxvii., p. 450.

was read at the meeting of the Physical Society in March 1890.

The Accipitrine style of wing coverts closely resembles that of the Gallinæ; with this essential difference that, owing to the group under consideration being without the fifth cubital remex, a displacement of all the coverts on the outer, or distal, side of the place of the missing feather results; and a difference in arrangement both marked and easily recognised is made evident. This style is common to several large groups of birds. These are (1) the PSITTACI, the STRIGES, the ACCIPITRES (properly so-called), the HERODIONES (=the Herons and the Bitterns only), the ANSERES, and the Cormorants. In reference to the last it may be mentioned that the STEGANOPODES, in which the Cormorants are usually placed, embraces birds with very diverse styles of wing coverts, and which are, therefore, perhaps related less closely than has been supposed. The wing of the Wild Duck (Fig. 14), in all but minor details, of no importance in this connection, will serve as an excellent type for every one of the groups just enumerated. It will be observed that there are usually either five or six feathers displaced in such a manner as to project considerably beyond the Median proper. I call this group, for convenience of reference, the Inframedian. In Mr Wray's paper they are ignored as a separate group, and in his figure of the Duck's Wing the artist has, no doubt unintentionally, minimised the extent of displacement.

VII. The GOURINE STYLE. — Reverting briefly to the GALLINÆ, we find in the Peristeropods, such as *Crax*, *Penelope*, and *Talegalla*, etc., that some of the distal feathers of the Medians show a distinct distal overlap (Fig. 9). There is thus three variations in overlap in the same row of feathers. In other respects the wing style is substantially the same as that of the normal GALLINÆ. As these birds possess the fifth cubital remex, there is, in consequence, no such dislocation as that described. But, supposing for the moment that the fifth cubital remex were absent, and that the coverts above were accordingly "faulted," as they would be, then the wing of the Peristeropods would agree in all essen-

tial particulars with that of the Crowned Pigeons, or the GOURIDÆ. A reference to the outline (Fig. 16) will serve to make that clear. The Peristeropods section of the Gallinæ is that which makes the nearest approach to the Columbæ; while amongst the Pigeons, it is in the GOURIDÆ that the group most approximates to the Fowls. It need hardly be pointed out that the evidence afforded by these superficial characteristics is corroborated by a study of other morphological details.

I do not, of course, seriously propose to include under one Suborder, birds now so diverse in external form and in habits as the Parrots and the Ducks, the Owls and the Herons, the Falcons and the Cormorants; but their community of structural characteristics, especially of such structural characteristics as in no way influence the welfare of their possessors at this period of the world's history, seems to point to their having had a common Sauropsidan ancestor at no very remote geological period.

VIII. The COLUMBINE STYLE.—In studying the wing styles seen throughout the group of Cuckoos, one is led step by step, from a slight modification of the Picarian style, to the style seen in the Ground Cuckoos (Centropodinæ). The normal Cuckoos are in this respect intermediate between the Picarian birds and the Pigeons, while the Ground Cuckoos approach the Peristeropods and the Gouridæ. In both the CUCULI and the Peristeropod Gallinæ distal overlap characterises most of the wing coverts. But both of these groups are mainly quincubital, or possess the fifth cubital remex, and therefore exhibit no "faulting" of the coverts. Were the flight feathers in question absent, and the "faulting" there in consequence, the wing of either of these groups would assume the characters of the Columbæ. The Pigeons in this respect, therefore, bear the same relation to the Peristeropods that the Accipitrine birds do to the other or Alectoropod section of the Gallinæ. The faulting of the coverts in the case of the Pigeons is singularly well marked, as an examination of the outline drawing of a Pigeon's wing (Fig. 17) will sufficiently show. This, as well as the other outlines, has been drawn from careful measurements, and has

been repeatedly compared with freshly-killed examples. To reduce it to a short description is next to an impossibility. I would here again remark that the line of separation between the Marginals and the Minors in the Pigeons baffles all attempts at definition. The two groups of feathers merge into each other by the most imperceptible gradations in the present case; although in most other birds there is not much difficulty in drawing a line of demarcation between them. Compare, for example, the wing of the Tern (Fig. 20) or that of the Wild Duck (Fig. 14), or again that of the Skylark (Fig. 4) with the Pigeon's wing, and note the ill-defined character of the feature in question in the last case.

The Domestic Pigeon is usually chosen as a convenient and easily-obtained type of bird structure in general. It may be so in some respects; but its wing, certainly, is anything but typical, and should on no account be selected to illustrate the arrangement of the covert feathers.

In comparing the effects of the faulting due to the absence of the fifth cubital remex in the Pigeon with the same phenomenon in, say, the Ducks, it will be noted that, whereas the feathers are faulted *beyond* the general limit of the coverts in the Ducks, etc., they are drawn up, or *shortened* in the case of the Pigeons. In other respects the Pigeon's wing forms as good an illustration of the value of the external characteristic here specially discussed, as is afforded by such birds as the Ducks, the Parrots, the Accipitrines, etc.

It should be noted that in the Columbine style of wing coverts the Medians, or those next above the Majors, exhibit distal overlap from one end of the series to the other. Distal overlap, indeed, characterises nearly the whole of the feathers in this group.

In the Pigeon Grouse (PTEROCLIDÆ) this last-named feature is carried to excess. I do not see anything whatever in the style of the wing coverts in this group to warrant its being separated far from the true Pigeons.

IX. The GRALLINE STYLE.—This modification is well represented by the wing of the Golden Plover (Fig. 18), which has already been mentioned as a central type for the whole of the EUORNITHÆ. In this wing it will be noticed

that the Medians, to the number of six feathers, show proximal overlap, and that the same mode of imbrication can be easily made out for the two rows of Minors, and there are traces of a third. Above these come the marginals, all lapping outward, or in the reverse direction to those below. These are the feathers originating on the Patagium, and they can be easily distinguished from the Minors in this example. The fifth cubital remex is absent. Consequently, we find all the coverts more or less faulted; in this case, as in the foregoing Accipitrine style, they are faulted outwards, instead of inwards as they are in the Pigeons. The Major Coverts show a trace of the dislocation; but in the group I have termed the Inframedials (which, of course, represent the outer six of the Medials faulted beyond the rest), the break is particularly well marked. It coincides here with a change in the direction of overlap; the Inframedials lapping distally instead of proximally, as to the remainder. The curious derangement of the feathers all along the line of the break, up to the anterior border of the wing, is remarkably striking in this case.

The distal overlap of the feathers on the outer side of the line of break characterises the whole of the birds now remaining to be noticed. The chief modifications that follow relate to the proportion of distal overlap to proximal in the case of the Medians and the Minors on the side of the break next the vertebral axis.

In the GRALLÆ, the families next mentioned have substantially the same wing style as the Golden Plover:—OTIDÆ, ŒDICNEMIDÆ, CHARADRIIDÆ, SCOLOPACIDÆ (possibly also the CARIAMIDÆ and the PALAMEDEÆ), GRUIDÆ, and *Tantalus*. To these I feel disposed to add the COLYMBIDÆ and the ALCIDÆ. Near to the ALCIDÆ the style of the wing coverts observed in many living specimens would lead me to place (1) the *Osprey*, and (2) the *Læmmergeier*. My son has taken considerable trouble in recording the wing style in living examples of these birds; and the results certainly do not appear to admit of any other conclusion. Possibly a more detailed examination of these admittedly-aberrant birds will reveal some other points of resemblance to the

Grallæ; and show that, like the Secretary Bird and the CATHARTÆ, these birds are raptorial forms of various groups only distantly allied to the true Accipitres. Some of the peculiarities of the Osprey's wing may arise from the absence of more than the fifth cubital remex.

X. The CICONINE STYLE.—No sharp line of definition is possible between the GRALLINE style and that under notice. The chief distinction lies in the fact that in most of this group the entire series of feathers next above the Major Coverts has *distal* overlap. The Tern (Fig. 20) shows this type remarkably well. With slight modifications this would equally well suit the Gulls, the Skuas, the Ibises, the Storks, the *Secretary Bird*, the Spoonbills, and the Flamingoes. The Ciconiine style is well seen also in the PERNIDÆ.

XI. The TUBINARINE STYLE.—A progressive increase in the number of feathers showing distal overlap leads us to such types as *Leptoptilus*, where nearly the whole of the cubital coverts are characterised by distal overlap. Near to these must be placed the Gannets, *Plotus*, and possibly the Pelicans, the Petrels, the Albatrosses, the Frigate Birds, and, certainly, the CATHARTÆ. So far as the wing style is concerned, the American Vultures differ entirely from the normal Birds of Prey, and exactly agree with the Petrels, the Albatrosses, the Frigate Birds, and the Adjutants. This last conclusion, derived entirely from the external characters presented by the disposition of the cubital coverts, is exactly in accordance with the deeper-seated morphology as revealed by dissection. This and the other facts of the same nature I have brought forward appear to me to afford strong presumptive evidence that the variations of style which have been noticed in this paper represent a survival of archaic structures whose differentiation dates back to a very remote period in the history of the Sauropsida. It is only because they have long ceased to influence in any way the welfare of the bearers that these various styles of wing coverts have remained unaffected, while other parts of the bird's organism have gradually changed through many stages of evolution.

In conclusion, I may briefly summarise the facts relating to the various modes of disposition of the Cubital Coverts as

follows—the Euornithæ being subdivided for this purpose in accordance with this feature alone.

Tabular View of the Chief Modifications of Wing Coverts in the Euornithæ.

A. Without Median Coverts, TROCHILIDÆ (Fig. 1), CYPSELIDÆ (Fig. 2), TROGONIDÆ, PARADISIIDÆ (Fig. 3).

B. With Median Coverts, which show proximal overlap throughout their outer and middle extent.

I. Coverts forming an uninterrupted, or unfaulted, series. (Fifth cubital remex generally present.)

(a) Never more than one row of Minors (where these are present) which show distal overlap (see Figs. 2a, 4, 5). The whole of the Passerines proper. No other birds.

(b) With two, or, at the most, three rows of Minor Coverts.

(1) Proximal overlap characterises all but the inner third of each row. All the normal Picarians (Fig. 7). For the Cuckoos and the Goatsuckers, see below.

(2) Distal overlap predominating, only the medial third of the Medians and the Minors showing proximal overlap. All the CUCULI (Fig. 6). (For the aquincubital representatives of the Cuckoos see under Goatsuckers, below.)

(c) Rarely less than four, sometimes with five, rows of Minor Coverts.

(1) Proximal overlap predominating. MELEAGRIDÆ (Fig. 8).

(2) Distal overlap of all the inner half of each row, the remainder overlapping proximally. All the Alectoropod Gallinæ (Fig. 10), Pheasants, Grouse, Quails, etc. Also the Tinamous and the Hemipods.

- (3) Some of the outer feathers of each row show distal overlap. The Peristeropod Gallinæ (Fig. 9), Curassows, Brush Turkeys, Megapods, etc.

II. Coverts interrupted, or faulted, in consequence of the absence of the fifth cubital remex.

- (a) Corresponding to the CUCULI; with two, or, at the most, three rows of Minor Coverts, with the Coverts lengthened by faulting, and the outer feathers reversed so as to overlap distally.

- (a) Predominant proximal overlap of the Medians—GOURIDÆ (Fig. 16).

- (b) Distal overlap of the interior third of the Medians and Minors—most of the Goatsuckers (Fig. 11).

- (b) Generally with more than three rows of Minor Coverts, which, with the Medians, show predominant proximal overlap over all but the inner third of each row. Usually with five Medians lengthened by the faulting consequent upon the absence of the fifth cubital remex. PSITTACI (Fig. 12), STRIGES, ACCIPITRES (Fig. 13), HERODIONES (Fig. 15), ANSERES (Fig. 14), and the Cormorants.

- (c) Distal overlap predominating, outer third of the Medians always showing distal overlap, and lengthened by the faulting. All the typical GRALLÆ (Figs. 18 and 18a), also *Steatornis*, and *Pandion* (Fig. 19).

C. Medians entirely with proximal overlap.

- (a) No clear division between the Minors and the Marginals. Outer Medians shortened. Normal COLUMBI (Fig. 17).

- (b) Minors and Marginals distinctly separated. Outer Medians lengthened. GRUIDÆ, LARIDÆ (Fig. 20),

COLYMBIDÆ, PHŒNICOPTERIDÆ, PLATALEIDÆ, *Tantalus*, CICONIIDÆ (except *Leptoptilus*), *Serpentarius*, PERNIDÆ.

- D. Coverts showing distal overlap over nearly the whole outer surface of the wing. *Leptoptilus* (Fig. 21), all the CATHARTÆ (Fig. 22), *Pelecanus*, *Fregata*, *Sula* (Fig. 23), *Plotus* (Fig. 24), PROCELLARIIDÆ.

XXX. *On the Occurrence of the Anchovy* (*Engraulis encrasicolus*) *in Scottish Waters.* By Professor J. COSSAR EWART, M.D., F.R.S.E.

(Read 19th March 1890.)

Professor Ewart reported the occurrence of Anchovies in December last in the Moray Firth, and exhibited several specimens. A considerable number were captured off Troup Head by the Buckie herring fishermen about the end of December, and it was said that with fine meshed nets a large number would have been taken. A few were also captured near the mouth of the Forth about the end of January by herring fishermen.¹

There is only one record of the existence of Anchovies in Scottish waters in former years. In Day's "British Fishes" (vol. ii., p. 207) it is mentioned that Mr Peach had taken Anchovies from herring nets off Wick. During the present winter Anchovies have been especially abundant off the south coast of England, and they are said to have been found on both the east and west coasts in larger or smaller numbers.

¹ In the end of May 1890 Mr R. Service, Dumfries, informed the Society's secretary that Anchovies were then abundant in the Solway, and forwarded a specimen captured by a shrimp trawl on the 30th of that month. On 18th June Professor Ewart received another taken in Loch Striven (Clyde)

XXXI. *Preliminary Notes on a Post-Tertiary Fresh-Water Deposit at Kirkland, Leven, and at Elie, Fifeshire.* By THOMAS SCOTT, F.L.S., Naturalist to the Fishery Board for Scotland.

(Read 16th April 1890.)

Since the publication of the paper on "The Ancient Lakes of Edinburgh," by Mr James Bennie of the Geological Survey and myself,¹ considerable additional information has been collected (solely by Mr Bennie), relating not only to the deposits referred to in that paper, but also to others of a similar character, either unknown to us when the paper was published, or our knowledge of which was not sufficiently full to enable us to include them in it. I anticipate that this additional information will probably be submitted to the Royal Physical Society during the next session. Meantime it has been considered desirable that the following notes on various species of Mollusca and Crustacea that have recently been observed in a post-Tertiary marl, at the Kirkland of Leven, and in a bed of loam at Elie station, should be now recorded.

I propose in the remarks I have to offer on these two deposits to refer to each separately, as by doing so a clearer idea will be had of the conditions under which each was formed, and it will also facilitate comparison between them. The need for this will become more obvious by an examination of the organic remains taken as a group that have been observed in each deposit. I will refer first to the

KIRKLAND MARL.

This marl occurs in Mr Kirkby's garden at the Kirkland of Leven, and is overlaid by from six to seven feet of sand and gravel, and it is owing to the fact that Mr Kirkby set his boys to dig holes down to it (and they seem to have entered heartily into the work) that samples of it were procured and forwarded to me through my friend Mr James Bennie.

¹ Proc. Roy. Phys. Soc. Edin., vol. x., part i., pp. 126-154 (1889).

This marl, which is very pure, is similar to that observed at Blackford Hill, referred to in "Ancient Lakes." In it are numerous small irregular concretions of a bluish colour, which were found to consist of carbonate of lime, mixed with a little earthy matter and iron, the latter being possibly the colouring agent. As far as has been ascertained, the extent of the deposit is somewhat limited. In the portion examined, organic remains, chiefly Molluscan and Entomostracan, were found to be more or less abundant. It is very probable that the fine chalk-like matrix in which the remains are imbedded consists mainly of comminuted shell debris, and to this source is probably also due the mineral concretions referred to. Though Molluscan remains were common, they comprised very few species—*Pisidium pusillum*, *Limnæa peregra*, *L. truncatula*, and *Planorbis nautilus* being nearly all the truly aquatic forms observed. A few others, such as *Succinea putris*, *Helix pulchella*, *Vertigo pygmæa*, var.,¹ were also noticed, and these were probably blown into the loch or washed down by rain from somewhere in the vicinity. A few seeds of flowering plants, spores of *Chara*, and macrospores of *Isoetes* also occurred in the material examined, the last being frequent. The Crustacea, however, are the most interesting of the organic remains found in this deposit. Three species of these are, so far as I know, now recorded for the first time as fossil, viz., *Erpetocypris strigata* (O. F. Müller), *Erpetocypris tumefacta* (Brady and Robertson), and *Cyprois flava* (Zaddach). It may be stated in passing that all three are found living in Duddingston Loch. Some time ago I exhibited to this Society a few type-slides of species of

¹ This shell, which was of frequent occurrence in the marl, is rather smoother and more glossy than the typical *Vertigo pygmæa*. It differs chiefly, however, in the mouth being unfurnished with teeth. The absence of these cannot be ascribed to erosion, for even in those shells that are in perfect preservation no trace of teeth can be observed. In this respect it agrees with *V. edentula*, but the form of the shell is certainly that of *V. pygmæa*. From its neat appearance I propose, provisionally, to name this variety *V. pygmæa*, var. *concinna*. [Since the foregoing note was written I have had a communication from Mr J. W. Taylor, F.L.S., Leeds, in which he states that, in his opinion, this *Vertigo* belongs to a new species. In that case the name *concinna* will become specific instead of varietal.]

Ostracoda from various lochs in the vicinity of Edinburgh, and in my remarks concerning them I referred to Duddingston Loch as being the only known British habitat for *Cyprois flava*. I afterwards sent some specimens to Mr David Robertson, F.L.S., Millport, Cumbrae, and in a letter he sent me later on he says, "having these to compare by, I find that I have one of the same from Burnside Loch, near Rutherglen. It is one that was on my type-slide marked doubtful." This, taken in connection with its occurrence at Kirkland, is interesting, as indicating the possibility of the species having a wider distribution both in time and space than was previously supposed, and also tends to prove that it is indigenous and not an introduced species, as might have been thought had nothing further become known as to its distribution in Britain, than that it was found in the loch at Duddingston.¹ Another interesting relic from this deposit is the remains of an Amphipod, probably *Gammarus fluvialis*. Unfortunately, though the specimen is sufficiently perfect to show undoubtedly that it is an Amphipod, it is not perfect enough to allow of a more exact identification. It is notable that Amphipod remains are not common in these deposits—in fact, this is the first specimen I have observed, although material from many and different places has been examined. Somewhat analogous to this is the comparative rarity of the remains of Brachyurus Crustacea in the glacial clays of Scotland. It may, I think, be safely affirmed that these organisms were not uncommon during the formation of the deposits referred to, but it would appear that further investigation is required ere a satisfactory answer can be given to the question why their remains are so rarely met with in the Scotch post-Tertiary deposits.

It appears from the nature of this marl, and from the organisms contained in it, that it has been formed in a loch, or rather lochan, of perhaps limited area, but of considerable depth. The pond or lochan known as Corstorphine Loch (to the west of Edinburgh) seems to represent fairly well the physical conditions of the ancient Kirkland lake. The

¹ It is probable that *Cypris gibbosa* (Baird), recorded by Dr Baird from a ditch near the Surrey Zoological Gardens, June 1836, is *Cyprois flava*.

deposit is evidently of considerable antiquity, but more information is required ere any satisfactory statement can be made as to its age.

The following list includes all the Molluscan and Crustacean remains observed in the marl from the Kirkland deposit:—

MOLLUSCA.

- Pisidium pusillum* (Gmelin). Very common.
Planorbis nautilus (Linne). Not very common.
Limnæa peregra (Müller). Very common.
 „ *truncatula* (Müller). Rather scarce.
 „ *palustris* (Müller). Rare.
Succinea putris (Linne). Not very common.
Zonites fulvus (Müller). Rather scarce.
Helix pulchella (Müller). Frequent.
Vertigo pygmæa (Draparnaud). Rare.
 „ „ var. *concinna*. Frequent.

CRUSTACEA-AMPHIPODA.

- Gammarus fluviatilis*? Rare.

CRUSTACEA-OSTRACODA.

- Erpetocypris strigata* (O. F. Müller). Frequent.
 „ *tumefacta* (Brady and Robertson). Not common.
Cypridopsis vidua (O. F. Müller). Common.
 „ *villosa* (Jurine). Not common.
Potamocypris fulva, Brady. Not common.
Cyprois flava (Zaddach). Rather scarce.
Candona candida (O. F. Müller). Very common.
 „ *pubescens* (Koch). Very common.

I will now refer to the Elie deposit.

In 1867 the Rev. T. Brown, F.R.S.E., read a paper to the Royal Society of Edinburgh on the Arctic shell-clay of Elie and Errol, including some peaty layers interbedded with blown sand of more recent origin, which had been exposed in section during the construction of the East of Fife Railway

at Elie, and gives a list of some Molluscan shells he had observed in the lowermost of the interbedded peats. I thought at first that the deposit to which I am now to refer was one of the interbedded peats described by Mr Brown. Mr Bennie, who has examined it, informs me, however, that it does not seem to have any connection with these peat beds, and this is partly borne out by the difference of the contained organic remains. The present deposit occurs close to Elie railway station, and is very little below the present surface of the land. It is therefore more accessible than the Kirkland marl, and for this reason a larger quantity of it has been examined. The material of which it is composed is of a dark brownish colour, and consists partly of decayed vegetable tissue and partly of earthy matter. The remains observed in it comprise the shells of land and fresh-water Mollusca, the shells or tests of Ostracoda, the elytra and other remains of Coleoptera, and seeds, spores, and stems of plants. In the examination of a deposit such as this, considerable experience is necessary, owing to the difficulty there is in determining whether the organic remains are contemporaneous with the deposit, or merely recent introductions; and even the experienced student finds it no easy task to discriminate satisfactorily what is contemporaneous with the deposit from that which is of more recent date. Of course, the older the deposit, the less difficult it is to determine between old and new. In most of the post-Tertiary deposits which are at or near the surface, or which have been for a time exposed in section, the greatest care is required in the examination of the contained organic remains. The presence of such remains as the shells of bivalve Mollusca and Ostracoda, if more or less perfect, are not so likely to be misleading as some others, because their habitat is a more localised one, and a very little transportation has a tendency to separate the valves of the dead shells of such organisms.

In the following enumeration of species obtained from this deposit at Elie, the greatest care has been taken to include only such as appeared to be contemporaneous with it—several, such as *Helix hispida*, *Cochlicopa lubrica*, and others being excluded as doubtful.

MOLLUSCA.

- Pisidium pusillum* (Gmelin). Frequent.
- Valvata crustata* (Müller). Rare.
- Planorbis nautilus* (Linne). Rare.
- „ *contortus* (Linne). Frequent.
- Limnæa peregra* (Müller). Rare.
- „ *palustris* (Müller). Rare.
- „ *truncatula* (Müller). Frequent.
- Succinea putris* (Linne). Frequent.
- Zonites nitidulus* (Drap.). Not very common.
- „ *fulvus* (Müller). Frequent.
- Helix rotundata* (Müller). Rare.
- „ *pulchella* (Müller). Rare.
- „ ? Rare.
- Pupa marginata* (Drap.). Rare.
- Vertigo antivertigo* (Drap.). Common.
- „ *pygmæa* (Drap.). Frequent.
- „ *substriata*, Jeffreys. Rare.
- Carychium minimum*, Müller. Common.

OSTRACODA.

- Cypria ophthalmica* (Jurine). Rare.
- „ *serena* (Koch). Rare.
- Scottia browniana* (Jones). Frequent.
- Erpetocypris strigata* (O. F. Müller). Rare.
- Ilyocypris gibba* (Ramdohr). Frequent.
- Candona candida*, O. F. Müller. Not common.
- „ *kingsleii*, Brady and Robertson. Rare.

Seeds representing the following orders of flowering plants were also observed, viz., *Caryophyllaceæ*, *Chenopodiaceæ*, *Polygonaceæ*, *Naiadaceæ*, and *Cyperaceæ*; pieces of the stems of *Equisetum* (Horsetail), spores of *Chara*, and macrospores of *Isoetes* also occurred, but did not appear to be common. The Coleoptera remains observed represent at least two species, one of which is probably an *Elaphrus*—a beetle that frequents marshy ground.

The above list shows that the number of species of Mollusca from this deposit is 18 (7 aquatic, 2 marsh, and 9 terrestrial), whereas only 10 species have as yet been observed

in the Kirkland marl 15 aquatic and 5 terrestrial; another point deserving notice is the comparatively large number of species not truly aquatic, and the fact that three of these—which are almost the only common ones in the material—are confined to marshy ground helps to give us some idea of the conditions under which the deposit was formed. Another point to be noted is, that though several truly aquatic species have been obtained, they are all occasionally found in marshy situations as well as in ponds or lochs; moreover, the species of Ostracoda referred to in the list are as frequently found in marshes and pools as in more open water, if not more so. Thus all the evidence we at present possess regarding the physical conditions of the locality, when this deposit was being formed, tends to indicate the existence of a more or less extensive marsh, consisting of beds of aquatic vegetation, and intervening but comparatively shallow open water,—among the vegetation *Succinea*, *Vertigo antivertigo*, and *Carychium* would find a suitable habitat; the more open water would shelter *Pisidium*, *Valvata*, *Planorbis*, and *Limnæa*; while the other terrestrial species might, during dry seasons, readily wander within the limits of the marsh, and their shells thus become intermingled with the others in the gradually accumulating debris.

With the information we at present possess to guide us, it would be hazardous to attempt to make any statement as to the approximate age of the deposit. Its organic remains constitute no trustworthy guide, as they all belong to species now living. But though that be the case, and though there be no mass of overlying material, as is the case with the Kirkland marl, to imply antiquity, yet the appearance of the material seems to indicate the lapse of not a few generations since the deposit was formed.

The occurrence of *Scottia browniana* (Jones) in the Elie material is of some interest, as the following brief history of it will show. The species was first described by Professor T. R. Jones in 1850 in the *Annals and Magazine of Natural History* as *Cypris browniana*, having been discovered in a freshwater deposit at Clacton in Essex by Mr John Brown, F.G.S., of Stanway, Colchester. In 1875 Professor Prestwich recorded

the same species from the Island of Portland, where he had observed it in "a bed of sandy loam" in cliff debris. More recently, in 1882, Mr Clement Reid, F.G.S., in his paper on the "Geology of the Country around Cromer," Norfolk, reports it from that district. Up till this time it had been considered an extinct species. In November 1886, while examining the shores of Loch Fad (to the west of Rothesay, where I was for the time stationed), I observed in a small patch of marshy ground on the east side of the loch, and nearly opposite Barmore Wood, a species of Ostracod unknown to me. Professor G. S. Brady, to whom I sent some specimens, recognised it as *Cypris browniana*, Jones. Subsequently he ascertained, from an examination of the animal, that it was not a *Cypris* but the type of a new genus. It has therefore been figured and described in the recently published monograph by Drs Brady and Norman under the generic name mentioned in the list. It is not at all improbable that but for the fact of its having so recently been found living by the side of Loch Fad, its occurrence in the Elie loam might possibly have led to an erroneous opinion being formed as to the relative age of this deposit. The knowledge we now possess, however, as to its distribution in time, removes out of the way that which might otherwise have proved a stumbling-block.

In conclusion, I have to acknowledge the kindness of Professor G. S. Brady, F.R.S., who examined my type-slides (now exhibited) and revised my lists of Ostracoda; also my indebtedness to Mr J. W. Kirkby, of Kirkland of Leven, and his boys, and to Mr David Affleck, stationmaster, Elie, who at considerable trouble to themselves, freely supplied me with material for examination; and last, but not least, to Mr James Bennie of the Geological Survey, whose disinterestedness and readiness to oblige are well known to all who have the privilege of his acquaintance.

As some of the Ostracoda mentioned in the preceding notes are not included in the "Ancient Lakes," and as considerable changes have been made in the nomenclature, especially of the fresh-water species, I append a list with synonyms of those obtained from the two deposits here described.

LIST OF OSTRACODA, WITH SYNONYMS.

Family CYPRIDIDÆ.

Cypria,
Zenker.

Cypria ophthalmica (Jurine).

1820. *Monoculus ophthalmicus*, Jurine, Hist. des Monocles, p. 178, pl. xix., figs. 16, 17.
 1868. *Cypris compressa*, Brady, Mon. rec. Brit. Ostrac., p. 372, pl. xxxvi., fig. 6.
 1889. *Cypria ophthalmica*, Brady and Norman, Mon. M. and Fw. Ostrac. of the N. Atlantic and N.-W. Europe, p. 69, pl. xi., figs. 5-9.

Cypria serena (Koch).

1838. *Cypris serena*, Koch, Deutschlands Crustaceen, H. xxi., 22.
 1868. *Cypris lævis*, Brady, op. cit., p. 374, pl. xxiv., figs. 6-8.
 1889. *Cypria serena*, Brady and Norman, loc. cit., p. 70.

Scottia,
Brady and
Norman.Scottia browniana (Jones).¹

1850. *Cypris browniana*, Jones, Ann. and Mag. Nat. Hist., 2d ser., vol. vi., p. 25, t. 3, fig. 1.
 1856. „ „ Idem., Mon. Tert. Entom., p. 13, pl. i., fig. 1, a-d.
 1875. „ „ Prestwich, Quart. Jour. Geol. Soc., vol. xxx., fig. 1, p. 39.
 1882. „ „ C. Reid, Geol. of the Country around Cromer, p. 66 (Mem. Geol. Survey).
 1887. „ „ Jones and Sherborn, Geol. Mag., vol. iv., p. 459.
 1887. „ „ Brady, Fifth Ann. Rep. Fishery Board for Scot., App. F., p. 330, pl. xix., figs. 3, 4.
 1889. „ „ Jones and Sherborn, Suppl. Mon. Tert. Entom. of England, p. 9.
 1889. *Scottia* „ Brady and Norman, loc. cit., p. 72, pl. ix., figs. 23, 24; pl. xi., figs. 19-25.

(Now first recorded as fossil for Scotland.)

¹ A full bibliography to date is given for this species.

Erpetocypris strigata (O. F. Müller).

Erpetocypris,
Brady and
Norman.

1785. *Cypris strigata*, O. F. Müller, Entomostraca, p. 54, pl. iv.,
figs. 4-6.
1870. „ *ornata*, Brady (non Müller), Nat. Hist. Trans.
Northumb. and Durham, vol. iii., p.
364, pl. xiv., figs. 1-3.
1883. „ *strigata*, Lilljeborg, Cat. International Fisheries
Exhibition, London, Sweden Cat., p.
147.
1889. *Erpetocypris strigata*, Brady and Norman, Mon. M. and
Fw. Ostrac. of the N. Atlantic and
N.-W. Europe, p. 85, pl. viii., figs.
14, 15.

(Now first recorded as fossil.)

Erpetocypris tumefacta (Brady and Robertson).

1870. *Cypris tumefacta*, Brady and Robertson, Ostracoda and
Foraminifera of Tidal Rivers, Ann.
Nat. Hist., ser. iv., vol. vi., p. 13, pl.
iv., figs. 4-6.
1889. *Erpetocypris tumefacta*, Brady and Norman, Mon. M. and
Fw. Ostrac. of the N. Atlantic and
N.-W. Europe, p. 87, pl. viii., figs.
5-7.

(Now first recorded as fossil.)

Cypridopsis vidua (Müller).

Cypridopsis,
Brady.

1785. *Cypris vidua*, Müller, Entom., p. 55.
1868. *Cypridopsis vidua*, Brady, Mon. rec. Brit. Ostrac., p. 375,
pl. xxiv., figs. 27-36, 46.
1869. „ *obesa*, Brady and Robertson, Ann. Nat. Hist.,
ser. iv., vol. iii., p. 364, pl. xviii.,
figs. 5-7.
1889. „ *vidua*, Brady and Norman, Mon. M. and Fw.
Ostrac. of the N. Atlantic and N.-W.
Europe, p. 84, pl. xiii., fig. 27.

Cypridopsis villosa (Jurine).

1820. *Monoculus villosa*, Jurine, Hist. des Monocles, p. 78.
1868. *Cypridopsis villosa*, Brady, op. cit., p. 377, pl. xxiv., figs.
11-15; pl. xxxvi., fig. 9.

**Potamocy-
pris, Brady.**

Potamocypris fulva, Brady.

1868. *Bairdia fulva*, Brady, *op. cit.*, p. 474, pl. xxviii., fig. 21.
 1870. *Potamocypris fulva*, Brady, Nat. Hist. Trans. Northumb.
 and Durham, p. 366, pl. xiv., fig. 4.
 1889. „ „ Brady and Norman, Mon. M. and
 Fw. Ostrac. of the N. Atlantic and
 N.-W. Europe, p. 93, pl. xxii., figs.
 13-17.

**Cyprois,
Zenker.**

Cyprois flava (Zaddach).

1838. (?) *Cypris gibbosa*, Baird, Mag. Zool. and Bot., vol. ii., p.
 137, pl. v., fig. 15; Nat. Hist. Brit.
 Entom. (1850), p. 156, pl. xix., fig. 8.
 1844. „ *flava*, Zaddach, Sym. Crust. Prusa. Prodr., p. 83.
 1883. *Cyprois dispar*, Lilljeborg, International Fisheries Exhibi-
 tion, London, Sweden Cat., p. 147.
 1889. „ *flava*, Brady and Norman, Mon. M. and Fw.
 Ostrac. of the N. Atlantic and N.-W.
 Europe, p. 97, pl. viii., figs. 18, 19;
 pl. xii., figs. 13-21, 38.

(Now first recorded as fossil.)

**Candona,
Baird.**

Candona candida (Müller).

1785. *Cypris candida*, Müller, Entom., p. 62, tab. vi., figs. 7-9.
 1850. *Candona lucens*, Baird, Brit. Entom., p. 160, tab. xix.,
 fig. 1.
 1868. „ *candida*, Brady, Mon. rec. Brit. Ostrac., p. 383,
 pl. xxv., figs. 1-9; pl. xxxvi., fig. 13;
 and pl. xxxvii., fig. 1.
 1889. „ „ Brady and Norman, Mon. M. and Fw.
 Ostrac. of the N. Atlantic and N.-W.
 Europe, p. 98, pl. x., figs. 1, 2, and
 14-23.

Candona pubescens (Koch).

1837. *Cypris pubescens*, Koch, Deutschlands Crustaceen, etc., H.
 xi., p. 5.
 1868. *Candona compressa*, Brady, *op. cit.*, p. 382, pl. xxvi., figs.
 22-27.
 1868. „ *albicans*, Idem., *ibidem*, p. 381, pl. xxv., figs.
 20-25; pl. xxxvi., fig. 12 (junior).

1889. *Candona pubescens*, Brady and Norman, Mon. M. and Fw.
Ostrac. of the N. Atlantic and N.-W.
Europe, p. 101, pl. xii., figs. 32-37.

Candona kingsleii, Brady and Robertson.

1785. ? *Cypris detecta*, Müller, Entom., p. 49, tab. iii., figs. 1-3.
1870. *Candona kingsleii*, Brady and Robertson, Ann. and Mag.
Nat. Hist., ser. iv., vol. vi., p. 17.
1889. „ „ Brady and Norman, Mon. M. and Fw.
Ostrac. of the N. Atlantic and N.-W.
Europe, p. 102, pl. ix., figs. 19-22 ;
pl. xiii., fig. 19.

(Now first recorded as fossil.)

Ilyocypris gibba (Ramdohr).

Ilyocypris,
Brady and
Norman.

1808. *Cypris gibba*, Ramdohr, Mag. und Gesellsch. naturforsch.
Freunde zu Berlin, ii., p. 91.
1868. „ „ Brady, *op. cit.*, p. 369, pl. xxiv., figs. 47-54 ;
pl. xxxvi., fig. 2.
1889. *Ilyocypris gibba*, Brady and Norman, Mon. M. and Fw.
Ostrac. of the N. Atlantic and N.-W.
Europe, p. 107, pl. xxii., figs. 1-5.

XXXII. *Notes on the Palæozoic Species mentioned in Lindley and Hutton's "Fossil Flora."*¹ By R. KIDSTON, F.R.S.E., F.G.S.

(Read 16th April 1890.)

To the student of Fossil Botany, but especially to the British palæontologist, the species figured and described by Lindley and Hutton should be thoroughly understood. Owing, however, to several circumstances, this is often very difficult.

This paper is an attempt to ascertain, if possible, the true value of several of their species, which, owing to the loss of some of their types, and the fragmentary condition of many

¹ The Fossil Flora of Great Britain ; or, Figures and Descriptions of the Vegetable Remains found in a Fossil State in the Country. By John Lindley, Ph.D., etc., and Wm. Hutton, F.G.S., etc. London. Vol. i., 1831-33 ; vol. ii., 1833-35 ; vol. iii., 1835-37.

of the original specimens which are still preserved, is a work of considerable difficulty. Such a paper I have long intended preparing, owing to the difficulties I have myself experienced in past years in identifying their plants.

Two catalogues of the "Hutton Collection"¹ have already appeared. The first, entitled "Catalogue of the Hutton Collection of Fossil Plants, including a Synoptical List of the Chief Carboniferous Species not in the Collection," by G. A. Lebour, Newcastle-upon-Tyne, 1878,² contains a list of all the specimens then existing in the "Hutton Collection," with appended notes. The second is "A Catalogue of Fossil Plants from the Hutton Collection, presented by the Council of the Mining Institute to the Natural History Society, 1883, by Richard Howse."³

This latter catalogue deals only with the specimens in the museum of the Natural History Society, but contains almost all the types and specimens now extant which belonged to the late William Hutton, and thus practically represents his collection. The catalogue also contains notes and references. But in regard to the union of species proposed in this catalogue, in many cases I entirely dissent, as well as to many of Mr Howse's identifications.

In the following notes I will confine myself to the original work of Lindley and Hutton, and deal only with the specimens figured and described by them, and make such observations on their types and original specimens as may be thought necessary; or, in those cases where the types are lost, my remarks must be confined to their figures and to other specimens which appear to throw light on the subject.

I take this opportunity of thanking Mr T. Dinning, honorary secretary to the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, for his uniform kindness in giving me every facility for examining the "Hutton

¹ Now in the Natural History Museum, Newcastle-on-Tyne.

² Drawn up by order of the Council of the North of England Institute of Mining and Mechanical Engineers.

³ From Nat. Hist. Trans. of Northumberland, Durham, and Newcastle-upon-Tyne, vol. x., 1888.

Collection" during various visits made to Newcastle with that object.

In any criticisms on such a work as Lindley and Hutton's "Fossil Flora," the extent of the knowledge of fossil botany at the time the book was written must be taken into consideration.

The "Fossil Flora" began in 1831, and was continued till 1837. Perhaps no better idea can be given of the position of fossil botany at that time than by mentioning a few of the works on fossil botany then existing.

Several books, in which the subject had been more or less considered, had previously appeared in Britain. These were—"Lithophylacii Britannici Ichnographia" of E. Luid, published in 1699;¹ the "History of Rutherglen and East Kilbride," by the Rev. David Ure, printed in Glasgow in 1793; and the "Petrificata Derbiensia" of Wm. Martin, printed in Wigan, 1809. Some of the figures of these older works are really very fair, but the books as a whole only show—in varying degrees—that geologists were beginning to notice fossil plants.

In 1825 Artis published his "Antediluvian Phytology"—the first British work on fossil botany which treats the subject in a scientific spirit.

On the Continent, passing over the earlier writers, the first paper which placed fossil botany on a sound basis was Brongniart's "Sur la classification et la distribution des végétaux fossiles," 1822.² His "Prodrome" appeared in 1828, followed by his great standard work, "Histoire des végétaux fossiles," begun in 1828, the first volume of which was completed in 1837—the year in which the publication of Lindley and Hutton's "Fossil Flora" stopped.

Earlier, however, in 1804, Schlotheim published his "Beschreibung merkwürdiger Kräuter-Abdrücke und Pflanzen-Versteinerungen." In a later and enlarged edition of this work, which appeared in 1820, names were given to the plants figured and described in the earlier edition.

¹ The first edition, "Londini et Lipsiæ, 1699," I have not seen. A second edition was published at Oxford, 1760.

² Mém. d. Muséum d. hist. nat., vol. viii. Paris.

Sternberg's "Versuch einer geognostisch-botanischen Darstellungen der Flora der Vorwelt" was begun in 1820, and completed by Corda in 1838.

These were the chief works on Fossil Botany, some of which were only being written while the "Fossil Flora" was appearing. Still the point where Lindley and Hutton's "Fossil Flora" breaks down under critical examination is the inaccuracy of the plates; and this charge cannot be brought, but in a slight degree, against their contemporary workers. It is a point difficult to excuse, and has led to much confusion.

In regard to some of the Lindley and Hutton species, of which the types are lost, if the figures of these are not more accurate than many of those of which the types have been preserved, possibly we may never be able to discover the plant they meant to represent, even though specimens of it may be well known and in our possession.

VOLUME I.

Pl. i. PINITES BRANDLINGI, Witham.

Locality.—Wideopen, near Gosforth, about five miles north of Newcastle-upon-Tyne.

Horizon.—Lower¹ Coal-Measures. It occurred in the Grindstone or Firestone bed, commonly known by the name of "Grindstone Post."

Witham, *Observ. upon Fossil Vegetables*, 1831, p. 31, pl. iv., figs. 1-4.

Pinites Brandlingi, Witham, *Internal Struct. of Fos. Veget., etc.*, 1833, p. 43, pl. ix., figs. 1-4; pl. x., figs. 1, 2, 3; pl. xvi., fig. 3.

Dadoxylon Brandlingii, Endlicher, *Synop. Conif. foss.*, p. 35.

Araucarioxylon Brandlingi, Kraus, in Schimper, *Traité d. paléont. végét.*, vol. ii., p. 382.

Cordaioxylon Brandlingii, Shenk, in Zittel, *Handb. der Palæont.*, Band. ii. Lief. iii., 1884, p. 24.

Cordailes Brandlingii, Göppert (Stenzel), *Nachtr. z. Kennt. d. conifer d. palæoz. Form.*, p. 12, pl. i., figs. 1-4 (in *Abhandl. d. Königl. Preuss. Akad. d. Wissensch. zu Berlin*, 1887).

¹ The term "Lower" is not used in reference to *local* geological horizons, but to indicate the position of the Coal Field in its relation to the other Coal Fields of Britain.

Remarks.—The above limited references to the synonymy of this widely-distributed species gives an epitome of the history of changes of opinion as to the affinities and position of this plant, changes mostly brought about by the discovery of more perfect specimens.

Grand' Eury was the first to point out that the wood of certain stems, which from their external and internal characters were shown to belong to *Cordaïtes*,¹ was similar in structure to the *Pinites Brandlingi*, Witham.²

Since this discovery the plant has been placed in the genus *Cordaioxylon* as *C. Brandlingii*, and more recently Göppert has described the wood simply as *CORDAITES BRANDLINGII*.³

There is little reason to doubt the identity of *Pinites Brandlingi* with the stem of *Cordaïtes*, and as showing more clearly the true nature of the fossil, perhaps Göppert is quite justified in the course he has taken.

But this discovery in regard to *Pinites Brandlingi* raises the whole question of the other *Araucarioxylon* species, and it undoubtedly favours the opinion that they most probably are also referable to *Cordaïtes*. In the other species of *Araucarioxylon*, however, absolute proof of this is, I believe, wanting.⁴

Pl. ii. PINITES WITHAMI, L. and H.

Locality.—Craighleith Quarry, near Edinburgh.

Horizon.—Calciferos Sandstone Series.

Remarks.—Schimper places this in *ARAUCARIOXYLON*, Kraus.

Pl. iii. PINITES MEDULLARIS, L. and H.

Locality.—Craighleith Quarry, near Edinburgh.

Horizon.—Calciferos Sandstone Series.

Remarks.—Lindley and Hutton only figure a transverse section of this stem, but transverse, radial, and tangential

¹ Renault, Cours d. botan. foss. Première Année, 1881, p. 83.

² Grand' Eury, Flore carbon. du Départ. de la Loire, etc., p. 261.

³ Göppert, *loc. cit.*, p. 12.

⁴ Since these notes were written an interesting communication on this subject, by F. H. Knowlton, has appeared in the Proc. U.S. Nat. Mus., vol. xii., pp. 601-17 (Smithsonian Institution), 1890.

sections are given by Witham.¹ The species appears to be very closely related to *Araucarioxylon Withami*, if really distinct from it.

Pl. iv. LEPIDODENDRON STERNBERGII

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of the Low Main Coal.

Remarks.—All the plants placed under *Lepidodendron Sternbergii* by Lindley and Hutton are, I believe, referable to LEPIDODENDRON OPHIURUS, described by Brongniart in 1822.² In 1820 Sternberg, under the name of *Lepidodendron dichotomum*, figured certain *Lepidodendra*.³ Two species were probably included in these plates, and Brongniart, to distinguish them, named the plant on Sternberg's plates i. and ii. *Lepidodendron Sternbergii*, and that on his pl. iii. *Lepidodendron longifolium*.⁴ Some authors still regard *Lepidodendron Sternbergii*, Brongt. (= *Lepidodendron dichotomum*, Sternb., in part), as distinct from *Lepidodendron ophiurus*, Brongt. As far as I know the original types of *Lepidodendron Sternbergii* are lost, and, in such a case, there remains only the original figures and descriptions of the species from which to settle the question. These do not appear to me to afford evidence for determining this point. Or, to put it in other words, Sternberg's figures and descriptions do not afford sufficient data for the formation of a clearly defined species.

But whatever view may be taken of the specific individuality of *Lepidodendron Sternbergii*, Brongt., one point is perfectly clear, that the commonest *Lepidodendron* of our Lowest and Middle Coal-Measures is the *Lepidodendron ophiurus*, Brongt. I do not think that any solution of the difficulty can be found in the figures and descriptions of subsequent authors. Future discoveries may yet satisfactorily show the true position of *Lepidodendron ophiurus*,

¹ Inter. Struc. Foss. Veget., &c., 1833, p. 72, pl. vi., figs. 5, 6, 7, 8; pl. vii., figs. 7, 8.

² Class. d. végét. foss., pp. 27 and 90, pl. iv., figs. 1a, 1b.

³ Ess. monde prim., pls. i.-iii.

⁴ Prodrôme, p. 85, 1828.

Brongt., and *Lepidodendron Sternbergii*, Brongt., to each other—whether specifically distinct or synonymous—but at present I must admit my inability to grasp the characters which are said to distinguish *Lepidodendron Sternbergii*, Brongt., from *Lepidodendron ophiurus*, Brongt.

Pl. v. ULODENDRON MAJUS, L. and H.

Locality.—Jarrow Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Bensham Coal.

Pl. vi. ULODENDRON MINUS, L. and H.

Locality.—South Shields Colliery, county of Durham.

Horizon.—Lower Coal-Measures. Roof of High Main Coal.

Remarks.—I have already on several occasions expressed the belief that *Ulodendron majus* and *Ulodendron minus* are only different conditions and ages of the same species, and to prevent further confusion have recently adopted König's specific name for these plants, and now class them as SIGILLARIA DISCOPHORA, König sp.¹

The counterpart of the type of *U. minus* is still preserved in the "Hutton Collection."

Pl. vii., fig. 1. LEPIDODENDRON ACEROSUM, L. and H.

Pl. viii., figs. 1, 2. LEPIDODENDRON (?) ACEROSUM, L. and H.

Locality (pl. vii., fig. 1).—Bensham Colliery.

Horizon.—Lower Coal-Measures. Roof of the Bensham Seam.

Locality (pl. viii.).—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—The types of these figures appear to be lost, but from the examination of other specimens in the collection, there cannot remain any doubt that the *Lepidodendron acerosum*, L. and H., is a *Lepidophloios*, and similar to the plant named *Lepidophloios carinatus* by Weiss.²

¹ See Additional Notes on Some British Carboniferous Lycopods—Ann. and Mag. Nat. Hist., July 1889, p. 61, pl. iv., figs. 1, 1a; also Proc. Roy. Phys. Soc. Edin., vol. x., 1888-89, p. 90, pl. iv., figs. 1, 1a.

² Flora d. jüng. Stk. u. d. Rothl., p. 155.

The type of *Lepidostrobus pinaster*, L. and H. (vol. iii., pl. cxcviii.), in the "Hutton Collection" is also *Lepidophloios carinatus*, Weiss. The leaf-scars are well preserved on this example, and the central and two lateral cicatricules are well seen. The supposed bracts that spring from the *Lepidostrobus pinaster* (which is drawn upside down, as shown by more perfect specimens) are not organic, but splinters in the matrix. The original is quite unlike a cone, and it is difficult to conceive how such a figure of the fossil could have been produced.¹

Zeiller,² from the synonymy under the head of *Lepidophloios laricinus*, appears to unite *Lepidophloios carinatus* with *Lepidophloios laricinus*, Sternb., but I have evidence which leads me to think that these plants are specifically distinct. I hope presently to publish figures and descriptions of the examples upon which I have formed this opinion. The plant under discussion must now be called LEPIDOPHLOIOS ACEROSUS, L. and H. sp.

Pl. vii., fig. 2. LEPIDODENDRON DILATATUM, L. and H.

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of the Low Main Coal.

Remarks.—This is merely the older condition of LEPIDODENDRON OPHIURUS, Brongt.

Pl. vii., figs. 3, 4. LEPIDOPHYLLUM LANCEOLATUM, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Bensham Seam.

Pl. ix. LEPIDODENDRON GRACILE, L. and H.

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—This is the LEPIDODENDRON OPHIURUS, Brongt.

Pls. x., xi. LEPIDOSTROBUS VARIABILIS, L. and H.

Locality.—Jarrow Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Bensham Seam.

¹ See Catal. Palæoz. Plants, p. 172.

² Flore foss. d. bassin houil. d. Valenciennes, p. 471.

Remarks.—Under this head almost certainly the cones of several species are included. Fig. 2, pl. x., is most probably my *Lepidostrobos spinosus*,¹ it being apparently similar to the cones figured by Brongniart as "*Lepidostrobos*."²

Pl. xii. LEPIDODENDRON SELAGINOIDES.

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of the Low Main Coal.

Remarks.—The type of this plate, which is fortunately preserved, is a good specimen of BOTHRODENDRON MINUTIFOLIUM, Boulay sp.³ The characteristic leaf-scars of the genus *Bothrodendron* are well shown on the fossil. The figure is quite misleading.

Pl. xiii. SPHENOPHYLLUM EROSUM, L. and H.

Locality.—Jarrow.

Horizon.—Lower Coal-Measures. Shale above Bensham Seam.

Remarks.—This is the SPHENOPHYLLUM CUNEIFOLIUM, Sternb. sp. The original specimen is in the "Hutton Collection."

Pl. xiv. ASTEROPHYLLITES TUBERCULATA, L. and H.
(not Sternb.).

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—The types of this plate appear to be lost, but the type of pl. clxxx. is still in the collection. From the examination of this and other specimens, I believe the *Asterophyllites tuberculata*, L. and H., to be specifically distinct from the *Bruckmannia tuberculata*, Sternb., of which excellent figures have been given by Weiss⁴ under the name of *Stachannularia tuberculata*, Sternb. sp. *Stachannularia tuberculata* is, however, now known to be the cone of *Annularia stellata*, Schl. sp.

¹ Trans. Roy. Soc. Edin., vol. xxxiii., p. 396.

² Hist. d. végét. foss., vol. ii., pl. xxii., figs. 2, 3, 8.

³ *Rhytidodendron minutifolium*, Boulay, Le terr. houil. du nord de la France et ses végét. foss., p. 39. Lille, 1876.

⁴ Steinkohlen-Calamarien, part i., p. 17, pl. i., figs. 2-4; pl. ii., figs. 1-3 and 5 (left); pl. iii., figs. 3-10 and 12, 1876.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

2. The second part of the document outlines the various methods and techniques used to collect and analyze data. It includes a detailed description of the experimental procedures and the statistical analysis performed.

3. The third part of the document presents the results of the study. It includes a series of tables and graphs that illustrate the findings of the research. The data shows a clear trend of increasing activity over time.

4. The fourth part of the document discusses the implications of the findings. It suggests that the results have significant implications for the field of study and may lead to further research in this area.

5. The fifth part of the document concludes the study. It summarizes the key findings and provides a final statement on the importance of the research.

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5. The fifth part of the document concludes the study and summarizes the key findings. It reiterates the importance of the research and the need for continued investigation in this field.

CALAMOCCLADUS by Schimper under the
US.

fig. 1. BECHERA GRANDIS.

Colliery.

Coal-Measures. Roof of Low Main Coal.
probably the stem of SPHENOPHYLLUM.

STEROPHYLLITES GRANDIS, L. and H.

(not Sternb.).

Colliery, near Newcastle-upon-Tyne.

Coal-Measures. Roof of Low Main Coal.
y be a small specimen of CALAMOCCLADUS
sp. Lindley and Hutton's plant must
Bechera grandis, Sternb. (= *Calamocladus*
from which it is essentially distinct.

LEPIDODENDRON OBOVATUM.

Colliery.

Coal-Measures. Roof of Bensham Seam.

CALAMITES ; its phragma.

Colliery.

Coal-Measures. Roof of Bensham Coal

ES ; a crushed portion of the stem (?).

Colliery.

Coal-Measures. Roof of the Bensham

xii. CALAMITES MOUGEOTII.

izon.—"Sandstone of the Edinburgh Coal

is clearly not the *Calamites Mougeotii*,
from the Grès bigarré,¹ but I am quite
species to which it should be referred.

s it amongst his "*Species dubiæ*," under

ité d. paléont. végét., vol. i., p. 278 = *Equisetum*

I therefore propose to name the *Asterophyllites tuberculata*, L. and H. (not Sternb.), STACHANULARIA (?) NORTHUMBRIANA, Kidston.

PL. xv. CALAMITES NODOSUS, L. and H.

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—The main stem in this figure is the CALAMITES RAMOSUS, Artis. The supposed foliage branch has no connection with the stem, and is a branch with cones, referable to the genus *Palæostachya*. The fruit of *Calamites ramosus* which is known, is generically distinct (*Calamostachys*) from the *Palæostachya* occurring on this slab.¹ The type is in the "Hutton Collection."

PL. xvi. CALAMITES NODOSUS, L. and H.

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—The type of this figure is also preserved in the collection. The plate only shows one, of the remains of at least six stems, that occur on the slab. Not having the necessary works of reference beside me when examining the fossil, I could not determine it further than merely to refer it to the genus PALÆOSTACHYA.

PL. xvii. ASTEROPHYLLITES GRANDIS, L. and H. (not Sternb.).

Locality.—Felling Colliery, near Newcastle.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—The type, which is in the "Hutton Collection," may probably be referred to Weiss' genus CALAMITINA (*Cyclodadia*, L. and H.), but the specimen is not very distinctly preserved, and the foliage is too faintly indicated to allow of its true form being discovered.

PL. xviii. ASTEROPHYLLITES LONGIFOLIA.

Locality.—Jarrow Coal-Mine.

Horizon.—Lower Coal-Measures.

Remarks.—The original specimen appears to be lost. The

¹ See Weiss, Steinkohlen-Calamarien, Heft ii., 1884, p. 98, plates—but especially v., fig. 2; vi.; and xx., figs. 1, 2.

plant is placed in *CALAMOCCLADUS* by Schimper under the name of *C. LONGIFOLIUS*.

Pl. xix., fig. 1. *BECHERA GRANDIS*.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—This is probably the stem of *SPHENOPHYLLUM*.

Pl. xix., fig. 2. *ASTEROPHYLLITES GRANDIS*, L. and H.
(*not Sternb.*).

Locality.—Felling Colliery, near Newcastle-upon-Tyne.

Horizon.—Lower Coal-Measures. Roof of Low Main Coal.

Remarks.—This may be a small specimen of *CALAMOCCLADUS Equisetiformis*, Schl. sp. Lindley and Hutton's plant must not be confused with *Bechera grandis*, Sternb. (= *Calamocladus grandis*, Sternb. sp.), from which it is essentially distinct.

Pl. xixbis. *LEPIDODENDRON OBOVATUM*.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Bensham Seam.

Pl. xx. *CALAMITES*; its phragma.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Bensham Coal Seam.

Pl. xxi. *CALAMITES*; a crushed portion of the stem (?).

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of the Bensham Seam.

Pl. xxii. *CALAMITES MOUGEOTII*.

Locality and Horizon.—"Sandstone of the Edinburgh Coal Field."

Remarks.—This is clearly not the *Calamites Mougeotii*, Brongt., brought from the Grès bigarré,¹ but I am quite ignorant as to the species to which it should be referred.

Schimper² places it amongst his "*Species dubiæ*," under

¹ See Schimper, *Traité d. paléont. végét.*, vol. i., p. 278 = *Equisetum Mougeotii*.

² *Loc. cit.*, vol. i., p. 321.

the name of *Calamites Lindleyi*, given it by Sternberg to distinguish it from Brongniart's plant.

Pls. xxiii., xxiv. PEUCE WITHAMI, L. and H.

Locality.—Sandstone Quarry, Hill Top, near Ushaw, about 4 miles N.-W. of the City of Durham.

Horizon.—(?)

Remarks.—Schimper places this in *Cedroxylon*, Kraus, under the name of CEDROXYLON WITHAMI.

I have only met with one specimen of the plant, which I received from Mr John Young, F.G.S., and which was supposed to have come from the neighbourhood of Manchester.

Pl. xxv. ASTEROPHYLLITES FOLIOSA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of the Bensham Seam.

Remarks.—I have failed to discover any character by which this can be distinguished from ANNULARIA RADIATA, Brongt. (the foliage of *Calamites ramosus*, Artis).

The type of *Asterophyllites foliosa*, L. and H., is preserved in the "Hutton Collection."

Pl. xxv., fig. 2. ASTEROPHYLLITES GALIOIDES, L. and H.

Locality.—Barnsley Coal Field.

Horizon.—Middle Coal-Measures.

Remarks.—I have recently received specimens of *Annularia microphylla*, Sauveur,¹ from near Barnsley (Lindley and Hutton's locality), collected by Mr W. Hemingway. Till receiving these specimens I had met with no plant that explained the *Asterophyllites galioides*, and I now think that there is little doubt as to Sauveur's *Annularia microphylla* (1848) being the *Asterophyllites galioides*, L. and H. (1832). As Lindley and Hutton's name is the older of the two, the plant must now be distinguished as ANNULARIA GALIOIDES, L. and H. sp.

Pl. xxvi. LEPIDOSTROBUS ORNATUS, L. and H.

Locality.—Barnsley Coal Field.

Horizon.—Middle Coal-Measures.

¹ Végét. foss. d. terr. houil. d. Belgique, pl. lxxix., fig. 6, 1848.

Remarks.—This species is probably founded, more on a condition of preservation than on individual definite characters. What the authors of the "Fossil Flora" treat as the apex is the base of the cone, and it is now well known that the bases of the bracts bore *sporangia*, not *seeds* as originally supposed. *Lepidostrobus ornatus* might be conveniently placed under *LEPIDOSTROBUS VARIABILIS*, L. and H., which is a very *wide* species. The form *ornatus* is frequent, especially in ironstone nodules.

Pl. xxvii. SPHENOPHYLLUM SCHLOTHEIMII, L. and H.
(not Brongt.).

Locality.—Somerset Coal Field.

Horizon.—Upper Coal-Measures.

Remarks.—The plant figured here is frequent in the Upper Coal-Measures of Somerset, but is, I believe, the *SPHENOPHYLLUM EMARGINATUM*, Brongt. In *Sphenophyllum Schlotheimii*,¹ the leaves are rounded in their upper margin or obovate, with numerous dichotomously divided veins. I have not yet met with *Sphenophyllum Schlotheimii* in Britain.

Pls. xxviii., xxix. NOEGGERATHIA FLABELLATA.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Shale over the Bensham Seam.

Remarks.—Schimper has created the genus *PSYGMOPHYLLUM*² for this and a few other species which were formerly placed in *Noeggerathia*.

Pls. xxxi.-xxxvi. STIGMARIA FICOIDES.

Pl. xxxvii. PECOPTERIS ADIANTOIDES, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of the Bensham Seam.

Remarks.—The figure of this plant is very inaccurately

¹ *Palmacites verticillatus*, Schlotheim, *Flora d. Vorwelt*, p. 57, pl. ii., fig. 24; Zeiller, *Sphenophyllum Schlotheimii*, Brongt., *Bull. Soc. Géol. d. France*, 3^e sér., vol. xiii., p. 140, pl. viii., fig. 4.

² *Traité d. paléont. végét.*, vol. ii., p. 193.

drawn. In the plate the pinnæ are represented as being of almost equal width throughout their whole length, and abruptly terminated by an odd leaflet. In the specimen which is preserved in the "Hutton Collection," the apices of all the pinnæ are broken off, hence their termination, as represented in the plate (which is about two-thirds natural size), are purely imaginary. The drawing of the pinnules is also incorrect, the plant being, in fact, merely a specimen of *NEUROPTERIS HETEROPHYLLA*, Brongt.

PL. xxxviii. *PECOPTERIS HETEROPHYLLA*.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures. High Main Coal.

Remarks.—This is clearly the *ALETHOPTERIS DECURRENS*, Artis sp.¹

PL. xxxix. *SPHENOPTERIS CRENATA*, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Bensham Seam.

Note.—I defer my remarks on this species till a future time, as there are in my hands at present specimens of this and some allied species, which cannot well be treated of in this communication.

PL. xl. *ODONTOPTERIS OBTUSA*, L. and H. (*not* Brongt.).

Locality.—Leebotwood, 4 miles from Church Stretton, Shropshire.

Horizon.—Upper (?) Coal-Measures.

Remarks.—This is not the *Odontopteris obtusa*, Brongt. To distinguish Lindley and Hutton's plant from that species, Sternberg named it *ODONTOPTERIS LINDLEYANA*,² under which name it is now enrolled.

PL. xli. *NEUROPTERIS CORDATA*, L. and H. (*not* Brongt.).

Locality.—Leebotwood Coal Pit, 4 miles from Church Stretton, Shropshire.

Horizon.—Coal-Measures.

Remarks.—A great deal of confusion has arisen in regard

¹ *Filicites decurrens*, Artis, Antedil. Phyt., pl. xxi.

² *Ess. Fl. d. mond. prim.*, ii., p. 78.

to the *Neuropteris cordata*, Brongt.¹ In my paper on the "Fossil Flora of the Radstock Series," the subject has been fully discussed.² I may merely mention here, that the true *Neuropteris cordata*, Brongt., has not yet, as far as I have seen, been discovered in Britain, and that Lindley and Hutton's plant, as well as all other British specimens that I have seen passing under the name of *Neuropteris cordata*, are the *NEUROPTERIS SCHEUCHZERI*, Hoffmann.

Pl. xlii. *CAULOPTERIS PRIMÆVA*, L. and H.

Locality.—Radstock, near Bath, Somerset.

Horizon.—Upper Coal-Measures.

Pl. xliii, fig. 3. *LEPIDOPHYLLUM INTERMEDIUM*, L. and H.

Locality.—Leebotwood, 4 miles from Church Stretton, Shropshire.

Horizon.—Coal-Measures.

Pl. xliii, figs. 1, 2. *CYPERITES BICARINATA*, L. and H.

Locality.—Leebotwood, 4 miles from Church Stretton, Shropshire.

Horizon.—Coal-Measures.

Remarks.—The grass-like leaves placed under *Cyperites bicarinata* are the foliage of *Sigillaria*, and possibly of some species of *Lepidodendron*.

These fossils, as far as I have been able to observe, have not two veins as supposed by Lindley and Hutton. The little ledges, formed by the two sides of a flat, central, single vein, form protected lodgments for the carbonaceous matter of the leaf, and often, after the greater part of this substance has been removed from the other portions of the fossil, the prominence of these two lines of carbonaceous material, which frequently conceal the two edges of the mid-rib, have given rise to the erroneous opinion that the leaves contain two veins.

Lepidophyllum trinerve, L. and H., and *Lepidophyllum binerve*, Lebour, are subject to the same explanation.

¹ Hist. d. végét. foss., p. 229, pl. lxiv., fig. 5.

² Trans. Roy. Soc. Edin., vol. xxxiii., p. 356, pl. xxiii., figs. 1, 2.

Pl. xlv. SPHENOPTERIS AFFINIS, L. and H.

Locality.—Limestone Quarries near Gilmerton, near Edinburgh.

Horizon.—Calciferous Sandstone Series.

Remarks.—From the structure of the fructification of this species, it is now removed from *Sphenopteris* and placed in CALYMMATOTHECA, Stur. Full references to the literature of the species are given elsewhere.¹

Pl. xlv. SPHENOPTERIS CRITHMIFOLIA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Bensham Seam.

Remarks.—I believe this species to be only a varietal form of EREMOPTERIS (SPHENOPTERIS) ARTEMISIAEFOLIA, Sternb.

Pl. xlvii. SPHENOPTERIS DILATATA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Bensham Seam.

Remarks.—This may perhaps be referable to the SPHENOPTERIS TRIFOLIATA, Artis sp. The species of this group are closely related to each other, and it is almost impossible to determine the true specific position of this specimen without an examination of the type, which appears to be lost.

Pl. xlviii. SPHENOPTERIS CAUDATA, L. and H.

Locality.—(?) Jarrow Colliery.

Horizon.—(?) Lower Coal-Measures. Roof of Bensham Seam.

Remarks.—This is referable to DACTYLOTHECA (FILICITES) PLUMOSA, Artis. There exists some doubt as to the specimen having come from Jarrow, and therefore this record cannot be relied on as far as the distribution of the species is concerned.

Pl. xlix. NEUROPTERIS LOSHIL.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures.

¹ Trans. Roy. Soc. Edin., vol. xxxiii., p. 145. Owing to communications I have lately had with Dr Nathorst, it appears that *Sphenopteris frigida*, Heer, and *Sphenopteris flexilis*, Heer, do not belong to this species. The figures of these plants are not very accurate.

Fortunate that the original of this plate is
re is very inaccurate. The plant is,
HETEROPHYLLA, Brongt. (= *Neur-*

NEUROPTERIS SORETIL

g Colliery.

wer Coal-Measures.

The original specimen of this plate is also pre-
at it is only NEUROPTERIS HETEROPHYLLA, Brongt., of
the plate gives an inaccurate figure.

Pl. li. NEUROPTERIS ACUMINATA.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures.

Pl. lii. NEUROPTERIS GIGANTEA.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Pl. liii. SPHENOPTERIS BIFIDA, L. and H.

Locality.—Burdiehouse, near Edinburgh.

Horizon.—Calciferous Sandstone Series.

Remarks.—From its fructification, *Sphenopteris bifida* is
now placed in CALYMMATOTHECA, Stur.¹

Pl. liv. SIGILLARIA PACHYDERMA.

Locality.—Killingworth Colliery, near Newcastle.

Remarks.—The state of preservation of this specimen pro-
hibits all attempts at a specific identification.

Pl. lv. SIGILLARIA PACHYDERMA.

Locality.—Killingworth Colliery, near Newcastle.

Remarks.—The original specimen of this plate is badly
preserved, and cannot be satisfactorily determined. An
examination of the specimen led me to believe that the plant
might be *Sigillaria mamillaris*, Brongt., but of this I could
not be certain.

¹ See TRANS. Roy. Soc. Edin., vol. xxxiii., p. 140.

Pl. lvi. SIGILLARIA ALTERNANS.

Locality.—Cramlington Colliery, Northumberland.

Horizon.—Lower Coal-Measures.

Pl. lvii. SIGILLARIA RENIFORMIS.

Locality.—"Newcastle."

Horizon.—Lower Coal-Measures.

Pl. lviii. SIGILLARIA CATENULATA.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—Pls. lvi., lvii., lviii. represent decorticated conditions of *Sigillaria*. I believe it quite useless to attempt to identify such specimens, as several well-marked species in the decorticated condition cannot be specifically distinguished.

Pl. lix. SIGILLARIA OCULATA.

Locality.—Killingworth Colliery, Northumberland.

Horizon.—Lower Coal-Measures.

Remarks.—The specimen figured by Lindley and Hutton is contained in the "Hutton Collection." The fossil is not well represented on the plate, but from a careful examination of the specimen, I believe it is probably *SIGILLARIA OVATA*, Sauv.¹

Pl. lxx. POLYPORITES BOWMANI, L. and H.

Locality.—Coal Pit, near the entrance of the Vale of Llangollen, Denbighshire.

Remarks.—This is a fish scale.

Pl. lxx. SIGILLARIA ORGANUM.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The preservation of this specimen is such as to prohibit any specific determination being made.

¹ Sauvcur, Végét. foss. d. terr. houil. d. Belgique, pl. li., fig. 2; Zeiller, Flore foss. d. bassin houil. d. Valenciennes, p. 522, pl. lxxix., figs. 4-7 (fig. 3?).

Pl. lxxi. SIGILLARIA RENIFORMIS.

Locality.—(?)

Remarks.—This is another decorticated specimen of *Sigillaria*, which cannot be specifically determined.

Pl. lxxii. SIGILLARIA (?) MONOSTIGMA, L. and H.

Locality.—Sandstone Quarry, Cramlington, Northumberland.

Horizon.—Lower Coal-Measures.

Remarks.—This is a single isolated rib of a *Sigillaria* in a decorticated condition.

Pls. lxxiii.-lxxv. FAVULARIA TESSELLATA.

Locality (pls. lxxiii., lxxiv.).—Overlying Coal Strata, at Garthen Colliery, near Ruabon, Denbighshire.

Locality (pl. lxxv.).—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Bensham Seam.

Remarks.—Not having seen the originals of these plates, it is difficult to express any opinion on them. It is probable that the specimens represented on plates lxxiii. and lxxiv. are the SIGILLARIA TESSELLATA, Brongt. I have, however, never seen any specimens that were identical with these figures, but the differences are probably more dependent on the artist of the plates than the specimens themselves.

Mr Howse mentions that the original of pl. lxxv. is in the Museum of the College of Physical Science, Newcastle, but I have not seen it. Judging from the figure, however, I am inclined to think their plant has been the SIGILLARIA ELEGANS, Sternb. sp.

Pl. lxxvi. CARDIOCARPON ACUTUM, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Shale from the Bensham Seam.

Remarks.—Mr Carruthers and other botanists have shown that these seeds were borne by the fossil named *Antholithes Pitcairniæ*, L. and H., which in turn is the fructification of *Cordaites*. To show the affinities of the fossils, they are usually now placed in Grand' Eury's genus *CORDAIANTHUS*.¹

¹ Grand' Eury, Flore carb. d. Départ. de la Loire, etc., p. 227.

Pl. lxxvii. CALAMITES APPROXIMATUS, L. and H. (*not* Brongt.).

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—This is not the *Calamites approximatus*, Brongt., but probably the *Calamites Schutzei*, Stur., which I regarded as a variety of *Calamites varians*, Sternb. Weiss places *Calamites varians* in his *Calamitina*. The plant may be denominated CALAMITINA VARIANS, var. SCHUTZEI, Stur. sp.¹ The specimen figured is in the "Hutton Collection."

Pl. lxxviii. CALAMITES. (With roots.)

Locality.—From the Newcastle Coal Field.

Remarks.—These I regard as the basal extremities of CALAMITES SUCKOWII, Brongt. The original is in the "Hutton Collection."

Pl. lxxxix. CALAMITES CANNAEFORMIS.

Locality.—(?)

Remarks.—This I also believe to be the basal portion of CALAMITES SUCKOWII, Brongt. In regard to *Calamites cannaeformis*, Schl., I must confess that I do not know what that plant is. Schlotheim's type consists of a basal extremity of a *Calamite*, but so preserved that there are no characters shown on which to found a species.

Under *Calamites cannaeformis*, Schl., botanists appear to have been in the habit of placing any large badly-preserved *Calamite* stems. The species seems to have no clearly defined scientific position.

VOLUME II.

Pls. lxxx., lxxxi. BOTHRODENDRON PUNCTATUM, L. and H.

Locality (pl. lxxx.).—Jarrow Colliery.

Horizon.—Lower Coal-Measures. High Main Coal Seam.

Locality (pl. lxxxi.).—Percy Main Colliery.

Horizon.—(?)

¹ See Weiss, Steinkohlen-Calamarien, part i., 1876; part ii., 1884. Berlin. (Abhandl. z. geol. specialkarte v. Preussen u. d. Thüringischen Staaten, Band ii., Heft. 1; Band v., Heft 2.)

Remarks.—This genus, so long thought by British botanists to be founded on badly-preserved specimens of "*Ulodendron*," has been shown by Zeiller,¹ from a specimen presented by Hutton to the Muséum d'histoire naturelle, Paris, to be a true genus, with which Boulay's genus *Rhytidodendron* is synonymous.² Even decorticated specimens of *Bothrodendron* can be generally determined from the excentric umbilicus of the large scars.

Pl. lxxxii. ANTHOLITHES PITCAIRNÆ, L. and H.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures. Shale associated with the Low Main Coal.

Remarks.—See notes under *Cardiocarpon acutum*.

Pl. lxxxiv. PECOPTERIS REPANDA, L. and H.

Locality.—Jarrow Coal-Mine.

Horizon.—Lower Coal-Measures.

Remarks.—The type of this species is not in a good state of preservation, either for understanding the characters of the plant or for comparing it with other species.

Pl. lxxxiv. HALONIA (?) TORTUOSA, L. and H.

Locality.—Sandstone Quarry, near South Shields.

Horizon.—Lower Coal-Measures.

Remarks.—This is probably only a different condition of the fossils named *Halonias regularis*, which are the fruiting branches of a LEPIDOPHLOIOS.

Pl. lxxxvi. HALONIA GRACILIS, L. and H.

Locality.—Low Moor, Yorkshire.

Horizon.—Middle Coal-Measures.

Remarks.—This is probably a LEPIDODENDRON. In the Ironstone nodules of the Dudley Coal Field and elsewhere, I have seen specimens of *Lepidodendron*, which, from unequally developed dichotomy, have a somewhat similar pinnate appearance.

¹ Bull. Soc. Géol. d. France, 3^e sér., vol. xiv., p. 178, pl. viii., fig. 1.

² Le terr. houil. du nord de la France et ses vég. foss., p. 39. Lille, 1876.

Pl. lxxxvii. CARPOLITHES ALATA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The *Carpolithes alata*, L. and H., is the TRIGONOCARPUS PARKINSONI, Brongt., enclosed in its pericarp. I have seen several specimens revealing this very clearly.

Pl. xc. CYCLOPTERIS OBLIQUA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—These large cyclopteroid pinnules were borne on the rachis of several species of *Neuropteris*, but from the figures here given it is impossible to determine the species to which they belong. They may possibly be referable to NEUROPTERIS HETEROPHYLLA, Brongt.

Pl. xcia. NEUROPTERIS INGENS, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—This species of *Neuropteris* is too ill defined to enable me to identify the plant indicated.

Pl. xcib. CYCLOPTERIS DILATATA, L. and H.

Locality.—Felling Colliery, near Newcastle.

Horizon.—Lower Coal-Measures.

Remarks.—This is another *Neuropteroid* pinnule. The nervation is not sufficiently indicated to determine the species. I believe, however, that it is referable to NEUROPTERIS HETEROPHYLLA, Brongt.

Pl. xciv. PECOPTERIS NERVOSA.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Shale from the Bensham Seam.

Remarks.—This is now regarded as a variety of *Mariopteris* (*Pecopteris*) *muricata*, Schl., and classed as MARIOPTERIS MURICATA, Schl. sp., var. NERVOSA.

Pl. xcv. KNORRIA TAXINA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of High Main Seam.

Remarks.—The *Knorria taxina*, L. and H., is the stem of CORDAITES, and the form which occurs commonly in the Lower Coal-Measures. The original is preserved in the "Hutton Collection."

Pl. xcvi. CALAMITES. The base of a stem.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of the Bensham Seam.

Remarks.—This is evidently referable to CALAMITES SUCKOWII, Brongt.

Pl. xcvi. KNOBRIA SELLONII.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The plant figured by Lindley and Hutton does not appear to be similar to Sternberg's *Knorria Sellonii*. The surface of Lindley and Hutton's specimen, which is preserved in the "Hutton Collection," is covered with fine transverse lines. When the light falls on the specimen at right angles to the direction in which these fine lines run, a series of rather coarser longitudinal lines is brought out. The scars do not show any definite structure, but are bounded by an irregular basal ridge, giving the appearance as if some organ had been forcibly broken off. In front of this ridge is a slight hollow, bounded by two longitudinal depressions. I have a somewhat similar fossil from the Radstock Coal Field, and am equally ignorant of its affinities.

Pls. xcvi., xcix. LEPIDODENDRON HARCOURTII, Witham.

Locality.—Hesley Heath, near Rothbury, Northumberland.

Horizon.—Coal-Measures.¹

¹ The type is in the York Museum.

Pl. cxiv. HIPPUITES GIGANTEA, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The type is preserved in the "Hutton Collection." The leaves appear to spring from the nodes, not as teeth of a sheath as represented in the plate, but as free and independent organs placed closely together. The specimen is similar to that figured by Weiss as "*Calamites* sp.," from the Bruckstrasse Mine, near Langendreer, Westphalia.¹ The plant figured by Lindley and Hutton may possibly be *Calamitina varians*, var. *insignis*, Weiss.²

Pl. cxv. SPHENOPTERIS ADIANTOIDES, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Pl. cxvi. MEGAPHYTON APPROXIMATUM, L. and H.

Locality.—Jarrow.

Horizon.—Lower Coal-Measures. Roof of High Main Coal.

Remarks.—I have previously united this with *Megaphyton frondosum*, Artis. As there is, however, a difference of opinion among botanists on this point, it had perhaps better be treated as a distinct species until further examined into.

Pl. cxvii. MEGAPHYTON DISTANS, L. and H.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures. Shale over Low Main Coal.

Remarks.—This is the MEGAPHYTON FRONDOSUM, Artis. The specific name *distans* cannot be substituted for *frondosum* on such grounds as those suggested by Lindley and Hutton.

Pl. cxviii. LEPIDODENDRON ELEGANS.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—I have not seen the original of this plate, but believe it is also referable to LEPIDODENDRON OPHIURUS, Brongt.

¹ Steinkohlen-Calamarien, part ii., 1884, pl. xvii., fig. 2, pp. 22 and 27.

² *Loc. cit.*, p. 63, pl. i., figs. 1-6; pl. xxviii., fig. 1.

Pl. cxxii. *PECOPTERIS LACINIATA*, L. and H.

Locality.—Jarrow.

Horizon.—Lower Coal-Measures.

Remarks.—*Pecopteris laciniata*, L. and H., is the *MARIOPTERIS MURICATA*, Schl. sp.

Pl. cxxiii. *SPHENOPTERIS MULTIFIDA*, L. and H.

Locality.—Near Oldham.

Horizon.—Coal-Measures.

Remarks.—The type of this species is not preserved in the collection. I originally thought that *Sphenopteris multifida* might be referable to *Urnatopteris tenella*, Brongt. sp., but recently some small fragments of a fern from South Lancashire and Yorkshire, which have come under my notice, may perhaps be Lindley and Hutton's species, and under their name I have recorded them. The pinnules, however, in these specimens are almost truncate, and not pointed, as in the enlargement given by the authors of the "Fossil Flora." I am therefore still in some uncertainty as to their plant.

Pl. cxxiv. *ASTEROPHYLLITES EQUISETIFORMIS*.

Locality.—Mines of Blackwood, Monmouthshire.

Horizon.—Coal-Measures.

Remarks.—This is the *ANNULARIA STELLATA*, Schl. sp.

Pl. cxxx. *CYCLOCLADIA MAJOR*, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Bensham Seam.

Remarks.—There are several specimens in the "Hutton Collection" which are placed under this name—among which is the type of *Cyclocladia major*. They belong to Weiss' genus *Calamitina*,¹ and the specimen figured by Lindley and Hutton is probably *CALAMITINA VARIANS*, Sternb. sp., var. *INCONSTANS*, Weiss, but it is too fragmentary for a satisfactory determination. Among the specimens in the "Hutton

¹ *Cyclostigma*, L. and H. (not Goldenberg), is the oldest name for these fossils, but the type is so imperfect that from it satisfactory generic characters cannot be obtained. Goldenberg (*Flora Sarapont. foss.*, Heft. i., p. 19, 1855) has also used the same name for another class of fossils. Under these circumstances it is perhaps better not to resuscitate the genus *Cyclocladia*.

Pl. cxlix. SIGILLARIA MURCHISONI, L. and H.

Locality.—"Knowlsbury Coal Field."

Remarks.—The type specimen appears to be lost, but judging from the figure, the fossil was evidently in too imperfect a condition for the creation of a species, as all critical characters seem to have been effaced.

Pl. cl. OTOPTERIS (?) DUBIA, L. and H.

Locality.—"Sandstone of the Knowlsbury Coal Field."

Remarks.—This is a *Rhacopteris*, and must be enrolled as RHACOPTERIS DUBIA, L. and H. sp.

The rachis is very thin,—not thick as might be supposed from the figure. The apparent thick rachis of the figure results from a fracture of the stone—the pinnules on the right being on a higher level than those on the left. The thin dark line on the right of the left-hand row of pinnules, towards the base, shows the thickness of the rachis. The pinnules are placed in two vertical series, not spirally as thought possible by Lindley and Hutton.

The type is in the collection of the Geological Society of London.¹

Pl. cli. SPHENOPTERIS MACILENTA, L. and H.

Locality.—Risca, Monmouthshire.

Horizon.—Coal-Measures.

Pl. clii. LEPIDOPHYLLUM TRINERVE, L. and H.

Locality.—Blackwoodia, Monmouthshire.

Horizon.—Coal-Measures.

Remarks.—This species is to be referred to LEPIDOPHYLLUM MAJUS, Brongt. The supposed occurrence of three nerves in this species is most probably an error of observation.²

Pl. cliii. PECOPTERIS LONCHITICA.

Locality.—(?)

Remarks.—Now placed in the genus ALETHOPTERIS.

¹ My thanks are due to the Society for the loan of this specimen.

² See *ante*, p. 359.

Pl. cliv. *PECOPTERIS DENTATA*.

Locality.—"From a coarse micaceous shale in the Newcastle Coal Field" (?).

Remarks.—This is the *DACTYLOTHECA PLUMOSA*, Artis sp. There is reason to doubt the accuracy of the locality given for this specimen.

Pl. clvi. *SPHENOPTERIS LATIFOLIA*, L. and H. (*not* Brongt.).

Locality.—"From the Bensham and Jarrow Coal Mines, where it is common."

Horizon.—Lower Coal-Measures.

Remarks.—This is the *SPHENOPTERIS OBTUSILOBA*, Brongt.¹ (= *Sphenopteris irregularis*, Sternb.).²

VOLUME III.

Pl. clx. *SPHENOPTERIS CRASSA*, L. and H.

Locality.—Burdiehouse, near Edinburgh.

Horizon.—Calciferous Sandstone Series.

Remarks.—The type of this species is in the collection of the Museum of Science and Art, Edinburgh. It has been refigured in the *Proc. Roy. Phys. Soc. Edin.*, vol. vii., p. 238, pl. v., fig. 1.

Pl. clxi. *LEPIDODENDRON LONGIFOLIUM*.

Locality.—"From the Newcastle Coal-Measures."

Remarks.—The specimen, which is in the "Hutton Collection," is so imperfectly preserved, that it is impossible to determine whether the fossil should be referred to *Lepidodendron* or *Sigillaria*.

Pl. clxii. *LEPIDOSTROBUS COMOSUS*, L. and H.

Locality.—Burdiehouse, near Edinburgh.

Horizon.—Calciferous Sandstone Series.

Pl. clxiii. *LEPIDOSTROBUS ORNATUS*, var. *DIDYMUS*, L. and H.

Locality.—Newhaven, near Edinburgh.

Horizon.—Calciferous Sandstone Series.

¹ Hist. d. végét. foss., p. 204, pl. liii., fig. 2*.

² Sternb., Vers., ii., p. 63, pl. xvii., fig. 4.

Pl. cxciiib. 1-4. TRIGONOCARPUM NOEGGERATHI.

Localities.—Holywell Colliery, and Wilmington Colliery, Newcastle Coal Field.

Horizon.—Coal-Measures.

Remarks.—This is the TRIGONOCARPUS PARKINSONI, Brongt.

Pl. cxciiic. TRIGONOCARPUM OBLONGUM, L. and H.

Locality.—In Sandstone, Hound Hill, near Pontefract.

Horizon.—Middle Coal-Measures.

Remarks.—In those localities where *Trigonocarpus Parkinsoni* occurs plentifully, there are usually associated with them specimens very similar to those described as *Trigonocarpum oblongum*, and which so graduate into typical TRIGONOCARPUS PARKINSONI that I can scarcely regard them as distinct.

Pl. cxcvi. CALAMITES INEQUALIS, L. and H.

Locality.—Sandstone Quarry, East of Sheffield.

Horizon.—Coal-Measures.

Remarks.—The specific character of this species is more than probably dependent on imperfect preservation. I am afraid this fossil must also be placed among the "imperfectly known species."

Pl. cxcvii. NEUROPTERIS HETEROPHYLLA.

Locality.—In shale worked for the ironstone it contains. A little north of Whitley, on the coast of Northumberland.

Remarks.—This is the NEUROPTERIS GIGANTEA, Sternb.

Pl. cxcviii. LEPIDOSTROBUS PINASTER, L. and H.

Locality.—South Shields.

Horizon.—Coal-Measures.

Remarks.—This species is founded on a small portion of the bark of LEPIDOPHLOIOS ACEROSUS, L. and H. For additional notes, see remarks under pl. vii.

Pl. cxcix. LEPIDODENDRON ELEGANS.

Locality.—Felling Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The original of this figure appears to be lost. From the plate it is impossible to determine the species to which it belongs, but if it is the same as that figured on pl. cxviii., as supposed by the authors, the plant is then *LEPIDODENDRON OPHIURUS*, Brongt., in all probability.

Pl. cc. *NEUROPTERIS HETEROPHYLLA*.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Pl. ccii. *PECOPTERIS SERLII*.

Locality.—Somerset Coal Field.

Remarks.—Now placed in the genus *ALETHOPTERIS*.

Pl. cciii. *LEPIDODENDRON STERNBERGII*.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures. Roof of Bensham Seam.

Remarks.—There is no data, either in the description or figure of this fossil, by which it appears possible to refer the specimen to any given species. The authors of the "Fossil Flora" identify it with their *Lepidodendron Sternbergii*, pl. iv. If this identification is correct, then the specimen figured here is *Lepidodendron ophiurus*, Brongt. I do not think, however, that it is safe to refer definitely the original of their plate cciii. to any given species.

Pl. cciv. *SPHENOPTERIS HÖNINGHAUSI*, L. and H. (*not* Brongt.).

Locality.—Felling Colliery (?).

Remarks.—This is not the *Sphenopteris Höninghausi*, Brongt. In my "Catalogue of Palæozoic Plants," to distinguish Lindley and Hutton's plant from Brongniart's species, I gave it the name of *SPHENOPTERIS EFFUSA*.¹

There seems to be some doubt as to the accuracy of the locality given by Lindley and Hutton.

Pl. ccv. *SIGILLARIA FLEXUOSA*, L. and H.

Locality.—Killingworth Colliery, near Newcastle.

Horizon.—Lower Coal-Measures.

Remarks.—The type specimen is not well preserved, and

¹ Page 75.

the form of the leaf-scars indistinct. The specimen is unworthy of specific rank, not possessing the necessary characters.

Pl. ccvi. *LEPIDODENDRON OOCEPHALUM*, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The type of this species is not in the collection, but being, as stated by the authors, "apparently the fructification in an incipient state," the retention of the specific name for this fossil can serve no practical purpose.

Pl. ccvii. *LEPIDODENDRON PLUMARIUM*, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—I have little doubt that this species is founded on a leafy branch of *LEPIDODENDRON OPHIURUS*, Brongt.

Pl. ccxb. *CARPOLITHES ALATA*, L. and H.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—See notes under pl. lxxxvii.

Pl. ccxi. *ASTEROPHYLLITES RIGIDA*.

Locality.—Jarrow Colliery.

Horizon.—Lower Coal-Measures.

Remarks.—The original specimen is apparently lost, and the plate being admittedly inaccurate, no satisfactory position can be assigned to the plant. Making the deductions from the drawing indicated by the authors, it may possibly be the *Calamocladus equisetiformis*, Schl. sp.

Pl. ccxii. *SPHENOPTERIS EXCELSA*, L. and H.

Locality.—Newcastle Coal Field (?).

Remarks.—This may perhaps be identical to their *Sphenopteris obovata*, but on this point I do not speak positively.

It is extremely probable that their type came from the Calciferous Sandstone Series of the neighbourhood of Edin-

burgh. Only on that horizon have I seen the species to occur. The locality given by Lindley and Hutton for their specimen is not thought to be correct.

Pl. ccxiii. *PECOPTERIS MARGINATA*, L. and H. (not Brongt.).

Locality.—"Coal of the North of England."

Remarks.—This is not the *Pecopteris marginata*, Brongt., as supposed by Lindley and Hutton. The authors say "a fern of frequent occurrence in the coal of the north of England." I believe the plant meant is the *Mariopteris* (*Pecopteris*) *muricatu*, Schl. sp., *forma nervosa*.

Pl. ccxiv. *SPHENOPTERIS CUNEOLATA*, L. and H.

Locality.—Newcastle Coal Field.

Remarks.—I have not seen any fern that could be identified with this species. The type appears to be lost.

Pl. ccxv. *PECOPTERIS OREOPTERIDIS*.

Locality.—Welbatch, near Shrewsbury.

Horizon.—Coal-Measures.

Remarks.—This is not the *Pecopteris oreopteridia*, Schl. sp., but most probably the *PECOPTERIS MILTONI*, Artis sp.

Pl. ccxvi. *CALAMITES APPROXIMATUS*, L. and H. (not Brongt.).

Locality.—Camerton, Somerset.

Horizon.—Radstock Series. Upper Coal-Measures.

Remarks.—This is the *CALAMITES CRUCIATUS*, Sternb., *var. SENARIUS*, Weiss.¹ The original is preserved in the University Museum, Oxford.

Pl. ccxvii. *CYCLOPTERIS OBLATA*, L. and H.

Locality.—Little Lever, near Bolton-le-Moor.

Horizon.—Coal-Measures.

Remarks.—The form of Cyclopteroid pinnules varies much on the same frond, owing to their position on the rachis. There is therefore no character in this species, as far as I know, by which it can be distinguished from some of the species already described in their work.

It can only be regarded as a Cyclopteroid pinnule of *NEUROPTERIS*.

¹ See Trans. Roy. Soc. Edin., vol. xxxiii., p. 340, fig. 1.

Pl. ccxviii. BOTHRODENDRON PUNCTATUM, L. and H.

Locality.—Ketley, Shropshire.

Horizon.—Coal-Measures.

Remarks.—More probably the impression of one of the large scars than the actual base of the cone.

Pl. ccxx. CARPOLITHES SULCATA, L. and H.

Locality.—Wardie Beach, near Newhaven, Midlothian.

Horizon.—Calciferous Sandstone Series.

Remarks.—These seeds are frequent in the shales of the Calciferous Sandstone Series, in the neighbourhood of Edinburgh.

This seed must not be confused with the *Carpolithes sulcatus*, Sternb., which is an altogether different species.¹

Pl. ccxxi. TRIGONOCARPUM DAWESII, L. and H.

Locality.—Peel Stone Quarry, near Bolton.

Horizon.—Coal-Measures.

Pl. ccxxii., figs. 2 and 4. TRIGONOCARPUM NOEGGERATHI.

Locality.—Peel Quarry, near Bolton.

Horizon.—Coal-Measures.

Remarks.—This is the TRIGONOCARPUS PARKINSONI, Brongt., not Sternberg's species.

Pl. ccxxii., figs. 1 and 3. TRIGONOCARPUM OLIVÆFORME,
L. and H.

Locality.—Peel Quarry, Bolton.

Remarks.—These are also referable to the TRIGONOCARPUS PARKINSONI, Brongt.

Pl. ccxxiii. PECOPTERIS BUCKLANDII.

Locality.—From the Newcastle Coal Field (?).

Remarks.—The original specimen is in the "Hutton Collection." It has not come from the Newcastle Coal Field, but more probably from Somersetshire. The fossil is clearly a *Neuropteris*, and I believe the NEUROPTERIS RARINERVIS, Bunbury. The plate is therefore very misleading.

¹ Sternb., Vers., ii., pl. x., fig. 8.

Pls. ccxxiv., ccxxv. STERNBERGIA APPROXIMATA.

Localities.—Somerset, Newcastle, and Halliwell Stone Quarry, near Bolton.

Horizon.—Coal-Measures.

Pl. ccxxviii. ENDOGENITES STRIATA, L. and H.

Locality.—(?)

Remarks.—It is almost impossible to form any conjecture of the true nature of such fossils as that here figured. One point is however clear, that they are not the remains of Endogens.

Pl. ccxxviii. HALONIA REGULARIS, L. and H.

Localities.—Halliwell Stone Quarry, near Bolton, and Peel Stone Quarry, near Bolton.

Horizon.—Coal-Measures.

Remarks.—The fruiting branches of LEPIDOPHLOIOS.

Pl. ccxxx. SPHENOPTERIS LINEARIS, L. and H. (*not* Sternb.).

Locality.—"In the North of England" (?).

Remarks.—This is the upper portion of their SPHENOPTERIS CRASSA.¹

CLASSIFIED LIST OF THE SPECIES MENTIONED IN THE "FOSSIL FLORA" ACCORDING TO THE FOREGOING NOTES.

CALAMITEÆ.

Group I. *Calamitina*, Weiss.

Calamitina verticillata, L. and H. sp.

Pl. cxxxix. *Calamites verticillatus*, L. and H.

Calamitina varians, Sternb. vars.

Pl. cxxx. *Cyclocladia major*, L. and H.

Pl. cxiv. *Hippurites gigantea*, L. and H.

Calamitina varians, Sternb., var. *Schützei*, Stur.

Pl. lxxvii. *Calamites approximatus*, L. and H.

¹ See Proc. Roy. Phys. Soc., vol. vii., p. 238 (footnote), pl. v.

Group II. *Eucalamites*, Weiss.*Calamites ramosus*, Artis sp.Pl. xv. *Calamites nodosus*, L. and H. (in part).*Calamites cruciatus*, Sternb., var. *senarius*, Weiss.Pl. cxxvi. *Calamites approximatus*, L. and H.Group III. *Stylocalamites*.*Calamites Suckowii*, Brongt.Pl. lxxviii. *Calamites*. (With roots.)Pl. lxxix. *Calamites cannaformis*, L. and H.Pl. xcvi. *Calamites*. (The base of a stem.)*Calamocladus*, Schimper.*Calamocladus grandis*, Sternb. sp.Pl. clxxiii. *Beckera grandis*.*Calamocladus equisetiformis*, Schl. sp.Pls. cxc., xcxi. *Hippurites longifolia*, L. and H.(†) Pl. xix, fig. 2. *Asterophyllites grandis*, L. and H.*Calamocladus longifolius*, Brongt. sp.Pl. xviii. *Asterophyllites longifolia*.(†) Pl. cxxxiii. *Asterophyllites jubata*, L. and H.*Palaeostachya*, Weiss.*Palaeostachya* sp.Pl. xv. (in part). *Calamites nodosus*, L. and H.Pl. xvi. *Calamites nodosus*, L. and H.

ANNULARIÆ.

Annularia, Brongt.*Annularia stellata*, Schl. sp.Pl. cxxiv. *Asterophyllites equisetiformis*.*Annularia radiata*, Brongt.Pl. xxv., fig. 1. *Asterophyllites foliosa*, L. and H.*Annularia galioides*, L. and H. sp.Pl. xxv., fig. 2. *Asterophyllites galioides*, L. and H.*Stachannularia*, Weiss.*Stachannularia* (†) *Northumbriana*, Kidston.Pl. xiv. *Asterophyllites tuberculata*.Pl. clxxx. *Asterophyllites tuberculata*.

SPHENOPHYLLÆ.

Sphenophyllum, Brongt.

Sphenophyllum cuneifolium, Sternb. sp.

Pl. xiii. *Sphenophyllum erosum*, L. and H.

Sphenophyllum emarginatum, Brongt.

Pl. xxvii. *Sphenophyllum Schlotheimii*.

Pinnularia, L. and H.

Pinnularia gracilis, Artis sp.

Pl. cx. A Fossil Aquatic Root.

Pinnularia capillacea, L. and H.

Pl. cxi. *Pinnularia capillacea*, L. and H.

FILICACEÆ.

Calymmatotheca, Stur.

Calymmatotheca affinis, L. and H. sp.

Pl. xlv. *Sphenopteris affinis*, L. and H.

Calymmatotheca bifida, L. and H.

Pl. liii. *Sphenopteris bifida*, L. and H.

Sphenopteris, Brongt.

Sphenopteris obtusiloba, Brongt.

Pl. clvi. *Sphenopteris latifolia*.

Pl. clxxviii. *Sphenopteris latifolia*.

(?) *Sphenopteris trifoliata*, Artis sp.

Pl. xlvii. *Sphenopteris dilatata*, L. and H.

Sphenopteris polyphylla, L. and H.

Pl. cxlvii. *Sphenopteris polyphylla*, L. and H.

Sphenopteris macilenta, L. and H.

Pl. cli. *Sphenopteris macilenta*, L. and H.

Sphenopteris Conwayi, L. and H.

Pl. cxlvi. *Sphenopteris Conwayi*, L. and H.

Sphenopteris adiantoides, L. and H.

Pl. cxv. *Sphenopteris adiantoides*, L. and H.

Sphenopteris cuneolata, L. and H.

Pl. ccxiv. *Sphenopteris cuneolata*, L. and H.

(?) *Sphenopteris obovata*, L. and H.

Pl. cix. *Sphenopteris obovata*, L. and H.

Sphenopteris Hibberti, L. and H.

Pl. clxxvii. *Sphenopteris Hibberti*, L. and H.

Sphenopteris excelsa, L. and H.

Pl. cxxii. *Sphenopteris excelsa*, L. and H.

Sphenopteris crenata, L. and H.

Pl. xxxix. *Sphenopteris crenata*, L. and H.

Pls. c. and ci. *Sphenopteris crenata*, L. and H.

Pls. c. and ci. *Schizopteris adnascens*, L. and H.

Sphenopteris effusa, Kidston.

Pl. cciv. *Sphenopteris Hoeninghausi*.

Sphenopteris crassa, L. and H.

Pl. clx. *Sphenopteris crassa*, L. and H.

Pl. ccxxx. *Sphenopteris linearis*.

Sphenopteris furcata, Brongt.

Pl. clxxxi. *Sphenopteris furcata*.

Sphenopteris multifida, L. and H.

Pl. cxxiii. *Sphenopteris multifida*, L. and H.

Rhacopteris, Schimper.

Rhacopteris dubia, L. and H. sp.

Pl. cl. *Otopteris* (?) *dubia*, L. and H.

Eremopteris, Schimper.

Eremopteris artemisiæfolia, Stern. sp.

Pl. xlv. *Sphenopteris crithmifolia*, L. and H.

Dactylothea, Zeiller.

Dactylothea plumosa, Artis sp.

Pl. xlviii. *Sphenopteris caudata*, L. and H.

Pl. cvii. *Pecopteris serra*, L. and H.

Pl. cliv. *Pecopteris dentata*.

Dactylothea plumosa, Artis, var. *dentata*, Brongt.

Pl. cxxxviii. *Sphenopteris caudata*.

Pecopteris, Brongt.

Pecopteris Miltoni, Artis sp.

(?) Pl. clxxxiv. *Pecopteris abbreviata*.

(?) Pl. cxxv. *Pecopteris oreopteridia*.

Mariopteris, Zeiller.

Mariopteris muricata, Schl. sp.

Pl. cxxii. *Pecopteris laciniata*, L. and H.

Mariopteris muricata, Schl. sp., forma *nervosa*, Brongt.

Pl. xciv. *Pecopteris nervosa*.

(?) Pl. ccxiii. *Pecopteris marginata*.

Alethopteris, Sternberg.

Alethopteris decurrens, Artis sp.

Pl. xxxviii. *Pecopteris heterophylla*, L. and H.

Pl. cxlv. *Pecopteris Mantelli*.

Alethopteris lonchitica, Schl. sp.

Pl. cliii. *Pecopteris lonchitica*.

Alethopteris Serlii, Brongt. sp.

Pl. ccii. *Pecopteris Serlii*.

Odontopteris, Brongt.

Odontopteris Lindleyana, Sternb.

Pl. xl. *Odontopteris obtusa*.

Neuropteris, Brongt.

Neuropteris heterophylla, Brongt.

Pl. xxxvii. *Pecopteris adiantoides*, L. and H.

Pl. xlix. *Neuropteris Loshii*.

Pl. l. *Neuropteris Soretii*.

Pl. cc. *Neuropteris heterophylla*.

Neuropteris gigantea, Sternb.

Pl. lii. *Neuropteris gigantea*.

Pl. cxcvii. *Neuropteris heterophylla*.

Neuropteris acuminata, Schl. sp.

Pl. li. *Neuropteris acuminata*.

Neuropteris Scheuchzeri, Hoffmann.

Pl. xli. *Neuropteris cordata*.

Caulopteris, L. and H.

Caulopteris primæva, L. and H.

Pl. xlii. *Caulopteris primæva*, L. and H.

Megaphyton, Artis.

Megaphyton approximatum, L. and H.

Pl. cxvi. *Megaphyton approximatum*, L. and H.

Megaphyton frondosum, Artis.

Pl. cxvii. *Megaphyton distans*, L. and H.

LYCOPODIACEÆ.

Lepidodendron, Sternberg.

Lepidodendron ophiurus, Brongt.

Pl. iv. *Lepidodendron Sternbergii*.

Pl. vii., fig. 2. *Lepidodendron dilatatum*, L. and H.

Pl. ix. *Lepidodendron gracile*, L. and H.

Pl. cxii. *Lepidodendron Sternbergii*.

(?) Pl. cxviii. *Lepidodendron elegans*.

(?) Pl. cxcix. *Lepidodendron elegans*.

Pl. ccvii. *Lepidodendron plumarium*, L. and H.

Lepidodendron obovatum, Sternb.

Pl. xixbis. *Lepidodendron obovatum*.

Lepidodendron Harcourtii, Witham.

Pls. xcvi, xcix. *Lepidodendron Harcourtii*.

Lepidophloios, Sternberg.

Lepidophloios acerosus, L. and H. sp.

Pl. vii., fig. 1. *Lepidodendron acerosum*, L. and H.

Pl. viii., figs. 1, 2. *Lepidodendron* (?) *acerosum*,
L. and H.

Pl. cxviii. *Lepidostrobus pinaster*, L. and H.

Lepidophloios sp.

Pl. lxxxiv. *Halonis* (?) *tortuosa*, L. and H.

Pl. cccxviii. *Halonis regularis*, L. and H.

(?) Pl. clxiv. *Pinus anthracina*, L. and H.

Lepidostrobus, Brongt.

Lepidostrobus variabilis, L. and H.

Pls. x., xi. *Lepidostrobus variabilis*, L. and H.

Pl. xxvi. *Lepidostrobus ornatus*, L. and H.

Pl. clxiii. *Lepidostrobus ornatus*, var. *didymus*, L. and H.

Lepidostrobus comosus, L. and H.

Pl. clxii. *Lepidostrobus comosus*, L. and H.

Lepidophyllum, Brongt.

Lepidophyllum majus, Brongt.

Pl. clii. *Lepidophyllum trinerve*, L. and H.

Lepidophyllum lanceolatum, L. and H.

Pl. vii., figs. 3, 4. *Lepidophyllum lanceolatum*,
L. and H.

Lepidophyllum intermedium, L. and H.

Pl. xliii., fig. 3. *Lepidophyllum intermedium*, L. and H.

Bothrodendron, L. and H.

Bothrodendron punctatum, L. and H.

Pls. lxxx., lxxxi. *Bothrodendron punctatum*, L. and H.

Pl. cccviii. *Bothrodendron punctatum*, L. and H.

Bothrodendron minutifolium, Boulay sp.

Pl. xii. *Lepidodendron selaginoides*.

Sigillaria, Brongt.

Sigillaria discophora, König sp.

Pl. v. *Ulodendron majus*, L. and H.

Pl. vi. *Ulodendron minus*, L. and H.

Sigillaria tessellata, Brongt.

Pls. lxxiii., lxxiv. *Favularia tessellata*.

(?) *Sigillaria elegans*, Sternb. sp.

Pl. lxxv. *Favularia tessellata*.

Sigillaria nodosa, Bowman.

Pl. cxcii. *Favularia nodosa*.

Cyperites, L. and H.

Cyperites bicarinata, L. and H.

Pl. xliii., figs. 1, 2. *Cyperites bicarinata*, L. and H.

Stigmaria, Brongt.

Stigmaria ficoides, Sternb. sp.

Pls. xxxi.-vi. *Stigmaria ficoides*.

Pl. clxvi. *Stigmaria ficoides*.

Pl. cxli. *Caulopteris gracilis*, L. and H.

CORDAITEÆ.

Cordaianthus, Grand' Eury.

Cordaianthus Pitcairniæ, L. and H. sp.

Pl. lxxvi. *Cardiocarpon acutum*, L. and H.

Pl. lxxxii. *Antholithes Pitcairniæ*, L. and H.

Stem of Cordaites.

Pl. xcv. *Knorria taxina*, L. and H.

Artisia, Sternberg.

Artisia approximata, Brongt.

Pls. ccxxiv., ccxxv. *Sternbergia approximata*.

CYCADACEÆ.

Psymphyllum, Schimper.

Psymphyllum flabellatum, L. and H. sp.

Pls. xxviii., xxix. *Noeggerathia flabellata*, L. and H.

SEEDS.

Carpolithus, Sternberg.

Carpolithus sulcatus, L. and H.

Pl. ccxx. *Carpolithes sulcata*, L. and H.

Trigonocarpus, Brongt.

Trigonocarpus Parkinsoni, Brongt.

Pl. lxxxvii. *Carpolithes alata*, L. and H.

Pl. cxliiic. *Trigonocarpum Noeggerathi*.

Pl. cxciib, figs. 1-4. *Trigonocarpum Noeggerathi*.

(?) Pl. cxciic. *Trigonocarpum oblongum*, L. and H.

Pl. ccxb. *Carpolithes alata*, L. and H.

Pl. ccxxii., figs. 2 and 4. *Trigonocarpum Noeggerathi*.

Pl. ccxxii., figs. 1 and 3. *Trigonocarpum olivæforme*,
L. and H.

Trigonocarpus ovatus, L. and H.

Pl. cxliia. *Trigonocarpum ovatum*, L. and H.

Trigonocarpus Dawesii, L. and H.

Pl. ccxxi. *Trigonocarpum Dawesii*, L. and H.

STEMS.

Cordaioxylon, Grand' Eury.

Cordaioxylon Brandlingi, Witham sp.

Pl. i. *Pinites Brandlingi*.

Cedroxylon, Kraus.

Cedroxylon Withami, L. and H. sp.

Pls. xxiii., xxiv. *Peuce Withami*, L. and H.

Araucarioxylon, Kraus.

Araucarioxylon Withami, L. and H.

Pl. ii. *Pinites Withami*, L. and H.

Araucarioxylon medullaris, L. and H. sp.

Pl. iii. *Pinites medullaris*, L. and H.

SPECIES FOUNDED ON OR IDENTIFICATIONS MADE FROM IMPERFECT SPECIMENS, which do not afford the necessary characters for subsequent identification, arranged in the order in which they occur in the "Fossil Flora."

Pl. xvii. *Asterophyllites grandis*, L. and H. (not Sternb.).

Pl. xix., fig. 1. *Bechera grandis*.

- Pl. xx. *Calamites* ; its phragma.
- Pl. xxi. *Calamites* ; a crushed portion of a stem.
- Pl. xxii. *Calamites Mougeotii*, L. and H. (not Brongt.).
- Pl. liv. *Sigillaria pachyderma*.
- Pl. lv. *Sigillaria pachyderma*.
- Pl. lvi. *Sigillaria alternans*.
- Pl. lvii. *Sigillaria reniformis*.
- Pl. lviii. *Sigillaria catenulata*.
- Pl. lix. *Sigillaria oculata*.
- Pl. lxx. *Sigillaria organum*.
- Pl. lxxi. *Sigillaria reniformis*.
- Pl. lxxii. *Sigillaria* (?) *monostigma*, L. and H.
- Pl. lxxxiv. *Pecopteris repanda*, L. and H.
- Pl. lxxxvi. *Halonis gracilis*, L. and H.
- Pl. xc. *Cyclopteris obliqua*, L. and H.
- Pl. xcia. *Neuropteris ingens*, L. and H.
- Pl. xcib. *Cyclopteris dilatata*, L. and H.
- Pl. xcvii. *Knorria Sellonii*.
- Pl. cviii. *Asterophyllites comosa*, L. and H.
- Pl. cxiii. *Lepidodendron selaginoides*.
- Pl. cxl. *Caulopteris Phillipsii*, L. and H.
- Pl. cxliib. *Poacites cocoina*, L. and H.
- Pl. cxlix. *Sigillaria Murchisoni*, L. and H.
- Pl. clxi. *Lepidodendron longifolium*.
- Pl. clxxiv. *Neuropteris attenuata*, L. and H.
- Pl. clxxxiii. *Neuropteris heterophylla*.
- Pl. cx cvi. *Calamites inequalis*, L. and H.
- Pl. cciii. *Lepidodendron Sternbergii*.
- Pl. ccv. *Sigillaria flexuosa*, L. and H.
- Pl. ccvi. *Lepidodendron ocephalum*, L. and H.
- Pl. ccxi. *Asterophyllites rigida*.
- Pl. ccxvii. *Cyclopteris oblata*, L. and H.
- Pl. ccxxiii. *Pecopteris Bucklandii*, L. and H. (not Brongt.).
- Pl. ccxxviii. *Endogenites striata*, L. and H.

XXXIII. *Note on a Recent Exposure of a "Washout" of Strata in New Redhall Quarry.* By JAMES BENNIE, of the Geological Survey of Scotland. [Plate XVI.]

(Read 16th April 1890.)

When miners in pit-workings find a seam of coal ending abruptly in loose sand and gravel, and passing through the same find the coal on the same level as before, they say the coal has been "washed out" by a torrent of water, which has left the sand and gravel in its place. The term "washout" has been adopted by geologists when they find a hollow cut out of the solid rocks, and filled in with boulder clay or the rubbish of it, and the width and depth of the hollow is taken as indicative of the volume of water and the time it took to cut it out. I think this term admirably describes the appearances in Redhall Quarry, to which I wish to direct attention. In the section presently exposed, the sandstone rock is seen to rise in a humph—flanked on either end by a hollow occupied by 10 or 12 feet of bituminous shale, and over all extends a mass of boulder clay 20 feet or so in thickness. The shale on both the east and west ends of the humph has been truncated, and the boulder clay comes down as it were and rests upon the sandstone rock at either end of the section. At the east end nothing remarkable is seen, but at the west end this extraordinary phenomena is displayed. Upon the edges of the truncated shale rest first 3 feet of boulder clay; then that boulder clay itself is truncated, and against the edges of both—that is, the boulder clay and the shale beneath—abuts a confused mass of what can only be regarded as rubbish from the boulder clay, consisting as it does of rough grit and gravel, shivers of shale, oblong slabs of sandstone, and rounded boulders of trap-rock and sandstone. It is evident that this mass of rubbish and boulders has been washed out of the boulder clay, which doubtless originally extended over the truncated edges of the shale on the west end of the section, as it still does over the east end, by some violent torrent of water, and redeposited in the hollow. Over this confused mass of rubbish, 20 feet or so of boulder clay has been deposited, overwhelming the whole.

The following is, I think, the sequence of events which are represented in the west end of the section :—*First*, there was the period of the lowest or first boulder clay, during which the shale which originally lay upon the sandstone, probably to a great thickness, was denuded till only the small patches now visible were left; then over all—the humph of sandstone and the two patches of shale at each end of it—boulder clay the ground moraine of a great ice-sheet was laid down to a thickness we have now no means of ascertaining, but it was probably great. *Second*, through some change of circumstances during this part of the glacial period, the ice was partially lifted from off the land, and water in the form of rapidly running rivers became possible, and one of these must have run close by the west end of Redhall Quarry, and cut into the boulder clay, and down through it to the sandstone, exposing anew the truncated edges of the shale, washing away the finer part of the boulder clay, and leaving the rougher parts, the pebbles, the shivers of shale, the slabs of sandstone, the rounded boulders of trap rock, all mixed higglety-pigglety, as shown in the photograph. There is, however, one regularity in this chaos. All the larger boulders seen *in situ* rest directly upon the slope of the truncated edges of the shale. They took this position doubtless, though sinking by their great weight through the gravelly rubbish till they grounded upon the slope, and did not trundle to the bottom of the slope, because though the gravel was quick as a quicksand is, through being surcharged with water, their weight was not sufficient to push the gravel aside, and overcome at the same time the friction necessarily opposed to their descent.

The moral to be drawn from the appearances presented by this wash-out is that the glacial period was not simple and uniform in its course, or short in its duration, but was varied and even diverse in its circumstances and lengthened in its time. Taking boulder clay to be moraine matter, the drift-wrack of an ice-sheet then in the first boulder clay, here represented by the denudation of the shale and the vestige of boulder clay which still lies on the top of the slope, we have, *first*, a great ice-sheet overspreading the whole face of the

country, grinding it down and leaving its drift of mud and stones behind it; then we have, *secondly*, water in its usual forms and its familiar ways, of rapid rivers and quiet lakes, cutting and carving and moulding the face of the country anew after its own fashion; and then we have, *thirdly*, a return of the ice-sheet with its concomitant drift of mud and stones and boulders overwhelming everything.

These conclusions, drawn from the washout presently exposed in New Redhall Quarry, are strengthened by examples of the same phenomena which have been exhibited in the adjoining quarries of Old Redhall and Hailes. One of these is thus described by Dr Fleming in his "Lithology of Edinburgh," page 57:—"At the sandstone quarry of Redhall a large deposit of stratified sand and gravel was observed a few years ago [from 1857] resting on the bituminous shale which covers the sandstone, and extending a considerable space near to the place where the engine has been since erected. The relation of this mass of sand and gravel could not be determined to the north and west though evidently resting in a hollow, but on the south it was observed reposing on the sandstone for several yards, and covered by the boulder clay which rested on the rock in other parts of the quarry. The clay seems to have flowed over it quietly, or to have been deposited on it without occasioning any particular contortions in the sand." This should perhaps be properly called a washin rather than a washout, yet it is probably but a part of the same phenomena, and had it been followed somewhat farther to the north, it might have been connected with the New Redhall washout described in this note. Dr Fleming also mentions that "in Hailes Quarry, to the westward, a deposit of sand occurred under boulder clay, and in a trough of the rock commingled with some slips of the clay and peat which rendered the phenomena somewhat obscure."

Since Dr Fleming's time we have had more emphatic washouts exposed than he noticed. One of these was described at a meeting of the Edinburgh Geological Society, 14th November 1864, as reported in the *Geological Magazine*, January 1865, p. 38. "Dr Page read a paper on the washout

at Hailes Quarry, where the superincumbent shales and underlying sandstone had been cut through to a depth of 60 feet, and to a width varying from 12 to 14 feet at the surface, but gradually narrowing to only 2 or 3 feet at bottom. It was a wedge-shaped gorge, smooth and polished on the sides by ice and water action, and now filled with clay and boulders, the produce of the glacial period during which the washout had been excavated." This washout, and others to which he alludes, Dr Page says were in fact old river courses of the country before and perhaps during part of the glacial period.

I remember of seeing in 1869 or 1870 a cut out of the sandstone exposed in the southern face of Hailes Quarry, which had been filled in with boulder clay, and that to keep the stones in it from falling and hurting the men working below, a wall of masonry was built against it. The size of the cut might be 20 or 30 feet in depth and 10 or 12 in width. It was not wedge-shaped, but square at the bottom. It might, however, be a portion of that described by Dr Page, in which the wedge form had disappeared, as the sandstone was quarried farther back from what it was in 1864. I have been lately told by one of the foremen of Hailes Quarry that some years ago they came upon a tunnel in the rock, formed by water as they supposed, because in the bottom of it there were pot-holes or whirlpools filled with stones, some of which were large enough to be called boulders. At present (1890) there is a space walled up same as the one I saw in 1869-70, and the layers of sandstone above are disturbed as if they had fallen into a hollow. This is probably the west end of the tunnel. The whole of these washouts might be portions of the river, I supposed, to account for the sand and gravel bed with boulders under Kingsknowe Farm House, as described in the paper on the "Ancient Lakes of Edinburgh," page 135 of this volume.

EXPLANATION OF PLATE.

The Plate exhibits the washout in almost its whole extent, 30 to 40 feet. Lowest bed seen is the sandstone in progress of quarrying. The plane on which the split boulder rests is the surface of the sandstone after the shale

has been removed. The solid mass against which the long crowbar stands is the shale which overlies the sandstone; about 10 feet is seen on the right, which dwindles down to nothing, as shown by the row of boulders along the slope coming down till they rest on the sandstone. Above and beyond the boulders is seen the rubbish of the washout, very thin on the right, but increasing to 10 feet or more on the left. In the upper part is shown the second boulder clay, which extends about twice as much farther upwards than is shown in the Plate.

XXXIV. Note on *Perichaeta indica*, an Exotic Species of Earthworm living in Hothouses in Kirkcudbrightshire.
By ROBERT SERVICE, Esq.

(Read 16th April 1890.)

Some months ago Mr Charles Fergusson, gardener at Cally House in this county, incidentally mentioned in the course of conversation, that in the hothouses under his charge there was an abundance of a strange earthworm that he had never seen anywhere else. He sent me a few specimens afterwards, and when these arrived, I at once remembered that I had seen the same species before, but where or when I could not recollect. Suspecting it must have been in some of our own hothouses, I instituted a diligent search, and after considerable hunting discovered plenty of the same species in a bed composed of cocoanut-fibre refuse and loam in which plants were growing. The men who are daily working amongst the plants declared that these worms had been there for years; but to show (I suppose) that they knew something about evolution, they added that the worms were only common earthworms that had been brought in from the outer world with soil, and that the extra heat and moisture had metamorphosed them into the hard, wiry, agile creatures they prove to be when handled!

On sending some of them to Mr F. E. Beddard, that gentleman kindly informed me they belonged to "an unidentified species of *Perichaeta*, a genus of earthworms generally distributed in the tropics of both hemispheres," and that they had doubtless reached this country amongst the roots of imported plants. Since then Mr Beddard, I observe, has

exhibited the worms at a meeting of the Zoological Society, under the name of *P. indica*.

The house I find these worms in is a plant stove, where the temperature seldom falls lower than 65°, and the place where they are most plentiful is in a bed of soil in which plants are growing. Underneath this bed are hot-water pipes, so that the soil is always at a higher average temperature than the air of the house. Here the worms seem to thrive very well, as they are met with in all stages. Their casts appear to be quite distinctive, being of finer mould—if one may use the term—and the casts are thrown farther from the mouth of the boring than is the case with other worms. They are extremely quick in their movements, and when handled wriggle more after the manner of an eel or reptile than what we are familiar with in any of our indigenous species.

Looking to the fact that there has been no communication between Cally and our place such as would have conveyed earthworms, and that each place, so to speak, has received these worms independently, there can be little doubt they are of general distribution in Britain. A general search in hothouses kept at high temperatures would, I am confident, confirm this opinion.

Mr Fergusson sends me the following note of his experience with these worms at Cally House:—"I first noticed these worms shortly after I came here in the summer of 1881 in our stoves, my attention being first drawn to them by their very lively movements when thrown out of the flower-pots. I knew at once they were something rare, as I had never come across them before, though I had a long experience in different parts of the three kingdoms. I showed them to all my naturalist friends as curiosities, but could get no information about them. Last year I sent some of them to my friend Mr Campbell, of Kelvingrove Museum, but they were new to him, and he sent some to the British Museum, where they appeared to be also unknown. I am very pleased to get them identified now. They are found in all our houses where we keep up a temperature of 60°, but never in any of the cooler houses; and though flower-pots in which

these worms are constantly being removed into other cooler houses for a time, yet after a little the worms die out or disappear in the lower temperature. The hotter the house, the livelier they always are; in the house where there is a large bed of soil, with a tank of hot water under, they are extra lively. They are far worse than the common earth-worms for working in flower-pots, choking up the drainage, and they seem to ramble about a great deal at night. I have no doubt they were first introduced into the houses here in the soil amongst the roots of orchids, or other foreign plants. They are very numerous, but very difficult to capture, as they are so quick in their movements. Whenever a pot is turned out, they at once retreat into the centre of the ball of earth, and cannot be got out without shaking out the roots of the plant."

XXXV. *A Revised List of British Echinoidea*.¹ By WILLIAM E. HOYLE, M.A. (Oxon.), F.R.S.E., Keeper of the Manchester Museum.

(Read 20th March 1889.)

The British collector has no memoir to which he can turn for the identification of the sea-urchins he may obtain more recent than the classic monograph of Edward Forbes, published forty-eight years ago. The admirable revision of the Echinodermata, drawn up in 1865 by the Rev. Canon Norman, unfortunately stopped short of the Echinoidea, and his numerous engagements, and the continually increasing demands upon his time made by the charge of his invaluable collection, have hitherto prevented him from completing the work.

The present paper owes its existence to a combination of circumstances. The Fellows of this Society will remember that in 1883 I contributed to our *Proceedings* (vol. viii.) a

¹ This catalogue was drawn up now more than a year ago, but various circumstances have combined to retard its appearance. This delay has been in several respects fortunate, and not least so in that it has made it possible to utilise Prof. Martin Duncan's "Revision of the Echinoidea" (*Journ. Linn. Soc.*, xliii. 1889).—W. E. H., June 11, 1890.

"Revised List of British Ophiuroidea;" and Mr A. Somerville, F.L.S., the energetic secretary of the Glasgow Natural History Society, suggested that I should continue the work which I then commenced, and kindly offered to communicate the paper to his society.

I felt, however, that as the Royal Physical Society had done me the honour of publishing my first work in this direction, any further papers I might be able to write upon the same subject ought in the first instance to be offered to it. At the time when Mr Somerville made his suggestion, I had just completed a series of dredgings in the Clyde sea area, and had thus collected a considerable number of some of our common forms; and, furthermore, I was spending some months in London, and was thus enabled to enjoy the inestimable privilege of being able to consult the collections and libraries of the British Museum; whilst, to crown all, my friend Dr Norman generously gave me access to the materials which he had been amassing for his own projected work upon the group.

In drawing up the present list I have naturally taken Forbes's handbook as a starting-point, and have endeavoured to add to it all those species which have since been recorded as British, and to bring the nomenclature into harmony with the principles now generally adopted. For this latter work the "Revision of the Echini," by Alexander Agassiz, is now the standard. He has treated the synonymy so exhaustively that to give it over again would simply be to reprint selections from his work, and would add nothing to the practical utility of such a catalogue as the present. I have therefore contented myself with a reference to the original creation of each species, and to such other authorities as are of essential service in its identification.

The attempt has also been made to give a brief diagnosis of each species, such as will enable the collector to identify it on the spot; but these notes will not stand in the place of more complete descriptions, still less can they be appealed to as decisive in critical cases, when one of the first authorities upon the group writes as follows:—"It seems almost hopeless to attempt to distinguish the species of *Echinus* known

as *E. elegans*, *E. norvegicus*, *E. melo*, and *E. Flemingii*.”¹ It will be obvious that a short differential diagnosis can only be regarded as of provisional value, and specimens will often have to be reserved for leisurely discrimination. Still it is believed that the characters here given will prove satisfactory in the majority of cases, so long as only British forms are taken into consideration.

With regard to distribution, I have given the British localities pretty fully, with the names of the authors who are responsible for them. The exact references may be obtained from the bibliography. The British area has been accepted as defined by Dr Norman² in his recent paper on that subject. It thus includes most of the deep water investigated by H.M.S. “Porcupine” and other vessels, as well as the Channel Islands, though I am quite disposed to agree with those who maintain that from a zoo-geographical standpoint they belong rather to France than to England. The extra-British range of each form is indicated generally, and in giving this I have relied mainly upon the following authors:—Coast of the United States, Verrill; Greenland and Denmark, Lütken; Norway and Sweden, Sars and Düben and Koren; France, Cailliaud and Fischer; Mediterranean, Ludwig and Carus; in addition to the comprehensive “Revision” and “Challenger” Report of Agassiz.

The present catalogue contains twenty-nine species as against twelve mentioned by Forbes, but, for reasons which will be given immediately, the evidence for the occurrence of some of these in British waters is so slight, that they must be omitted from consideration in all comparative discussions.

The list of species arranged systematically, according to the classification of Prof. Martin Duncan, is as follows:—

Order I. CIDAROIDA.

Fam. I. CIDARIDÆ.

1. *Cidaris* (*Dorocidaris*) *papillata*.
2. „ (*Porocidaris*) *purpurata*.

¹ Agassiz, “Blake” Echini, Mem. Mus. Comp. Zool., x., p. 39.

² Ann. and Mag. Nat. Hist., (6) v., p. 345, 1890.

Order II. DIADEMATOIDA.

Fam. II. ECHINOTHURIIDÆ.

3. *Phormosoma placentu.*
4. „ *uranus.*
5. *Asthenosoma hystrix.*
6. „ *fenestratum.*

Fam. III. ECHINOMETRIDÆ.

7. *Strongylocentrotus lividus.*
8. „ *dröbachiensis*
9. *Sphærechinus granularis.*

Fam. IV. ECHINIDÆ.

10. *Echinus esculentus.*
11. „ *acutus.*
12. „ *melo.*
13. „ *elegans.*
14. „ *microstoma.*
15. „ *norvegicus.*
16. „ *miliaris.*

Order III. CLYPEASTROIDA.

Fam. V. FIBULARIIDÆ.

17. *Echinocyamus pusillus.*

Fam. VI. SCUTELLIDÆ.

18. *Arachnoides placentu.*

Order IV. SPATANGOIDA.

Fam. VII. CASSIDULIDÆ.

19. *Neolampas rostellata.*

Fam. VIII. SPATANGIDÆ.

20. *Schizaster fragilis.*
21. *Brissoopsis lyrifera.*
22. *Spatangus purpureus.*
23. „ *Raschi.*
24. *Echinocardium cordatum.*
25. „ *pennatifidum.*
26. „ *flavescens.*

Fam. IX. POURTALESIIDÆ.

27. *Pourtalesia miranda*.28. „ *Jeffreysii*.29. „ *phyale*.

The following species should, I think, be excluded from the list :—

1. *Arachnoides placenta*.

This rests only upon a single specimen, said to have been obtained by Jameson, in very deep water, off the Island of Foula, Shetland; for the rest the species (and indeed the whole genus) is confined to the tropical and south temperate regions of the old world. In default of further evidence, it is not unreasonable to assume that some mistake must have occurred with reference to Jameson's example.

2. *Pourtalesia miranda*.

Considerable uncertainty hangs about the locality "Shetland Channel" given by Agassiz for this species. The station to which he refers¹ ("off Rockall, 1215 fathoms") is the one at which Gwyn Jeffreys dredged the two specimens which presented characters "too undefined for satisfactory definition," but which became the types of *Pourtalesia phyale*.²

Of the species just enumerated, the following thirteen are also found in Norwegian waters :—

Cidaris papillata.
Strongylocentrotus dröbachiensis.
Echinus esculentus.
 „ *acutus*.
 „ *elegans*.
 „ *norvegicus*.
 „ *miliaris*.

Echinocyamus pusillus.
Schizaster fragilis.
Brissopsis lyrifera.
Spatangus purpureus.
Echinocardium cordatum.
 „ *flavescens*.

The following eleven are also common to the Mediterranean :—

Cidaris papillata.
Strongylocentrotus lividus.
Sphaerechinus granularis.
Echinus acutus.
 „ *melo*.
 „ *miliaris*.

Echinocyamus pusillus.
Brissopsis lyrifera.
Spatangus purpureus.
Echinocardium cordatum.
 „ *flavescens*.

¹ Rev. Echin., p. 561.² "Porcupine" Echin., p. 749.

All these except *Echinus melo*, *Strongylocentrotus lividus*, and *Sphærechinus granularis* are also in the preceding list, so that we may conclude that one great contingent of the British Echinoid fauna is made up of forms extending from Norway round to the Mediterranean.

Some of them have a still more extended distribution, as, for example, *Cidaris papillata*, which extends across the Atlantic and even to the Philippines; *Echinus acutus*, reported from the United States, Ascension, and the Kermadec Islands; *Strongylocentrotus dröbachiensis*, recorded from Greenland; and *Echinocardium pennatifidum*, from the West Indies.

Another section of this fauna is derived from the deep water of the Atlantic, and would be excluded by those who contend that the British area should be limited by the hundred fathom line. Such forms are—

Cidaris purpurata.

Phormosoma placenta.

„ *uranus*.

Asthenosoma hystrix.

„ *fenestratum*.

Echinus microstoma.

Neolampas rostellata.

Spalangus Raschi.

Pourtalesia miranda.

„ *Jeffreysii*.

„ *phyale*.

CIDAROIDA.

Mouth and anus central and opposite, the latter within the dorso-central system; internal branchiæ only; jaws present, perignathic girdle discontinuous; both ambulacral and inter-ambulacral plates continued beyond the peristome to the true mouth.

CIDARIDÆ.

1. *Cidaris*, Klein.

Body spheroidal; peristome and periproct subequal; primary tubercles very large and perforated; spines of various forms.

Subgenus *Dorocidaris*, Agassiz.

1869. *Dorocidaris*, Agassiz, Bull. Mus. Comp. Zool., i., p. 253.

Ambulacral median area narrow; primary tubercles without crenulations, surrounded by a deeply-sunk scrobicular area, formed of close granulations; spines very long, often twice the diameter of the body; grooved, the ridges often consisting of rows of tubercles; pores disconnected.

1. *Cidaritis papillata*, Leske.

1873. *Nidaris papillata*, Leske, Addit. ad Klein Nat. Disp. Echin., p. 61, pl. xxxix., fig. 2.
 1874. " *Agassiz*, Kinnville, Man. d'Actinol., p. 231, pl. xxix, fig. 5.
 1875. " " Forbes, Brit. Starf., p. 146, cut.
 1885. " " Dänen & Koren, Öfver. k. Vet. Akad. Förh. för 1844, p. 114.
 1872. *Agassiz*, Agassiz, Rev. Echin., p. 105.
 1874. *Cidaritis papillata*, Wyr. Thomson, "Porcupine" Echin., Phil. Trans., p. 722, pl. lix., figs. 1-13.
 1874. " *affinis* Id., p. cit., p. 726, pl. lx.
 1874. " *papillata*, Loven, Études, pl. xx., figs. 168, 169 (peristome).
 1884. *Cidaritis papillata*, Carus, Prodr. faun. Medit., p. 98.

Diagnosis.

Orbital suborbital: ambulacra continuous from anal to oral regions: scutiferous tubercles, one in each interambulacral plate, none in the ambulacra: spines of several forms, primaries with ridges composed of tubercles.

Distribution.

British Seas.—Shetland (FORBES). N.-W. of Lewis, warm area, "Lightning" Exp. Station 13, 206 fms. (THOMSON, 1, p. 76). "Knight Errant" Exp., St. 1, 305 fms. (AGASSIZ, 4). Off Unst, 110-170 fms. (NORMAN, 3). Off Fair L., 70 fms. (PEARCEY). Cape Wrath, 280 fms. ("Porcupine" Exp., *vide* AGASSIZ, 2). Off St Kilda, 100 fms. (HOYLE, 1). W. of Ireland, "Porcupine" Exp. (1869), St. 17, 1230 fms. (THOMSON, 1, p. 89). Forty miles off Valentia, 110 fms. (CARPENTER, etc., p. 417). S. of Ireland, "Porcupine" Exp. (1870), St. 3, 690 fms. (THOMSON, 1, p. 181). Coast of Kerry (Brit. Mus.). S.-W. Ireland, 150-315 fms. (BELL, 3). S. of Ireland, 200-400 fms. (BELL, 4).

Other Localities.—Norway (SARS; AGASSIZ, 2; Copenhagen Mus.). Cape Sagres, 165 fms. ("Porcupine" Exp., *vide* AGASSIZ, 2). Mediterranean (THOMSON, 2; LUDWIG; CARUS; Brit. Mus.). Red Sea, St Helena, St Paul's Rocks, 70-80 fms., West Indies, 390 fms. (Brit. Mus.). Florida Gulf Stream, 40-150 fms. (POURTALES, *vide* AGASSIZ, 2). Florida to lat. 32° N., 100-842 fms. (AGASSIZ, 5). La Plata, Philippines (AGASSIZ, 5). Canary Is., 70 fms. Off Monte Video, "Challenger," St. 320, 600 fms. Philippine Is., "Challenger," Sts. 204 and 210, 100 and 375 fms. (AGASSIZ, 3).

Subgenus *Porocidaris*, Desor.

1854. *Porocidaris*, Desor, Synops. Echin. foss., p. 46.

1874. „ „ Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 726.

"Ambulacra broad and straight; pores wide apart, united by a groove; primary interradial tubercles with small . . . crenulated mamelons." Five diamond-shaped openings round the anal region of the test, filled with chitinous membrane, through which pass the oviducts; "some spines flattened, with strongly serrated edges."

2. *Cidaris purpurata* (Wyville Thomson).

1872. *Porocidaris purpurata*, Agassiz, Rev. Echin., pp. 152, 395, pl. i., figs. 37-41; pl. xxiv., fig. 11.

1873. „ „ „ Wyv. Thomson, Depths of the Sea, p. 101.

1874. „ „ „ Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 725, pl. lix., figs. 14, 15; pl. lxi.

Diagnosis.

Buccal membrane with imbricated scales, ten double rows of ambulacral, perforated up to the edge of the mouth, with double pores, in continuation of the pore-areas of the corona; interambulacral regions with imperforate scales.

I have not seen a specimen of this species.

Distribution.

British Seas.—N.-W. of Lewis, warm area, "Porcupine" Exp. (1869), Station 47, 542 fms. (THOMSON, 1, 2). "Knight Errant" Exp., St. 7, 530 fms. (AGASSIZ, 4).

Other Localities.—None recorded.

DIADEMATOIDA.

ECHINOTHURIIDÆ, Wyville Thomson.

Test thin and flexible; plates overlapping, ambulacral, and interambulacral in opposite directions; ambulacral pores trigeminal, one pair penetrates the ambulacral plate itself, the others two special accessory plates.

2. *Phormosoma*, Wyville Thomson.

1874. *Phormosoma*, Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 732.

"Plates of the corona only slightly overlapping, and forming a continuous shell without membranous interspaces. Ambulacral and interambulacral areas of the apical surface of the test with irregular rows of primary tubercles with small areolæ. Oral surface of the test different in character from the apical, with the areolæ of the primary spines large and deep, occupying a large portion of the surface both of the interambulacral and of the ambulacral plates" (Wyville Thomson).

3. *Phormosoma placenta*, Wyville Thomson.

1874. *Phormosoma placenta*, Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 745, pl. lxii.; pl. lxiii., figs. 1-8.
 1883. " " Agassiz, "Blake" Echini, Mem. Mus. Comp. Zool., x., p. 30, pl. xii.; pl. xv., figs. 3-19.
 1889. " " Bell, Ann. and Mag. Nat. Hist., (6) iv., pp. 436-438.

Diagnosis.

This species is remarkable for the large tubercles of the actinal surface, occupying the greater part of the ambulacral and interambulacral plates.

Distribution.

British Seas.—N.-W. of Lewis, warm area, "Porcupine" (1869), St. 90, 458 fms. (THOMSON, 1, 2). "Knight Errant," St. 4, 555 fms.; St. 7, 530 fms. (AGASSIZ, 4). West of Scotland and Ireland, 500-800 fms. (THOMSON, 2). S.-W. Coast of Ireland, 1000 fms. (BELL, 3).

Other Localities.—Coast of U.S.A., 458-1309 fms. (VERRILL). Lesser Antilles, 154-1242 fms. (AGASSIZ, 5).

4. *Phormosoma uranus*, Wyville Thomson.

1877. *Phormosoma uranus*, Wyv. Thomson, The Voyage of the "Challenger"; The Atlantic, i., p. 146, figs. 33, 34.
 1890. " *Pternii*, Agassiz, Bull. Mus. Comp. Zool., viii., p. 76.
 1881. " *uranus*, Agassiz, "Challenger" Echin., p. 103, pl. xviii., fig. 12.
 1883. " " Agassiz, "Blake" Echini, Mem. Mus. Comp. Zool., x., p. 35, pls. x., xi.

Diagnosis.

The test is of extreme tenuity; the primary ambulacral plates are fully as high as the corresponding interambulacral plates; there is but little difference between the upper and lower surfaces of the test. "The large tubercles are not closely packed, but irregularly arranged and limited to a comparatively narrow edge of the abactinal surface, immediately adjoining the ambitus" (Agassiz, 3, p. 103).

Distribution

British Seas.—N.-W. of Lewis, warm area, "Knight Errant," St. 4, 555 fms. (AGASSIZ, 4).

Other Localities.—Off Cape St Vincent, "Challenger," St. VI., 1525 fms. Off the Azores, St. 78, 1000 fms. (AGASSIZ, 3). Coast of U.S.A., 568-1080 fms. (VERRILL). Lesser Antilles, 399-1224 fms. (AGASSIZ, 5).

3. *Asthenosoma*, Grube.

1867. *Asthenosoma*, Grube, Jahresb. Schles. Ges. vaterl. Cult., p. 42.

1870. *Calveria*, Wyv. Thomson, in Carpenter, etc., Rep. "Porcupine" Exp., Proc. Roy. Soc., xviii., p. 445.

Test flexible, depressed; ambulacral and interambulacral areas composed of narrow plates, which are expanded and overlap extensively; oral and apical surfaces of test not different in character; calcareous deposit limited to centre of plates, which are thus membranous at the edges; each area has a principal vertical row of large perforate tubercles; rest of plate occupied by similar smaller tubercles in an irregular horizontal line.

5. *Asthenosoma hystrix* (Wyville Thomson), Agassiz.

1870. *Calveria hystrix*, Wyv. Thomson, in Carpenter, etc., Rep. "Porcupine" Exp., Proc. Roy. Soc., xviii., p. 445.

1872. *Asthenosoma hystrix*, Agassiz, Rev. Echin., pp. 98, 273, pl. iic, figs. 1-5.

1874. *Calveria hystrix*, Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 738, pls. lxiv., lxv.

1883. ,, ,, Agassiz, "Blake" Echin., Mem. Mus. Comp. Zool., x., p. 29, pls. xiii., xiv.

Diagnosis.

The characters distinguishing this species from the only other known British form are given below. I have only seen specimens of the present one.

Distribution.

British Seas.—Between Rockall and Rona, 547 fms. ("Porcupine" Exp., *fide* AGASSIZ, 2). 80 miles N.-W. of the Butt of Lewis, warm area, "Porcupine" (1869), St. 89, 445 fms. (THOMSON, 1). West coasts of Scotland and Ireland (THOMSON, 2).

Other Localities.—Coast of Spain and Portugal ("Porcupine" Exp., *fide* AGASSIZ, 2). Straits of Florida, 138 fms. (AGASSIZ, 2). West Indies, 103-373 fms. (AGASSIZ, 5).

6. *Asthenosoma fenestratum* (Wyville Thomson), Agassiz.

1874. *Calveria fenestrata*, WYV. THOMSON, "Porcupine" Echin., Phil. Trans., p. 741, pl. lxiii., figs. 9, 9a; pla. lxvi. and lxvii.

1881. *Asthenosoma fenestratum*, Agassiz, "Challenger" Echin., p. 210.

Diagnosis.

The overlapping portions of the plates are wider than in *A. hystrix*, but the strap-shaped portions are narrower, leaving wide membranous fenestræ between them; primary tubercles fewer and more remote than in *C. hystrix*; large pedicellariæ with four branches, each bearing a curiously curved disc.

Distribution.

British Seas.—Off Rockall ¹ (THOMSON, 2).

Other Localities.—Coast of Portugal (THOMSON, 2). Off Cape Finisterre, "Porcupine" (1870), St. 10, 81 fms. (THOMSON, 1).

ECHINOMETRIDÆ, Gray.

Test firm, regular; tubercles imperforate; ambulacral pores in four or more pairs; branchiæ oral.

4. *Strongylocentrotus*, Brandt.

1835. *Strongylocentrotus*, Brandt, Prodr. descr. anim. Mertens. obs., i., p. 63.

Test spheroidal, or subpentagonal depressed; tubercles non-crenulate, in primary and secondary vertical rows; pores in curves of four or five (sometimes, near the mouth, three) pairs; perignathic girdle with high ridges and a tall arch.

7. *Strongylocentrotus dröbachiensis* (O. F. Müller), Agassiz.

1776. *Echinus Dröbachiensis*, O. F. Müller, Zool. Dan. Prodr., p. 235.

1828. ,, *subangularis*, Fleming, Brit. Anim., p. 479.

¹ Agassiz (5) gives the depth as 445 fms., which would correspond to St. 89 of the "Porcupine" cruise of 1869.

1841. *Echinus neglectus*, Forbes, Brit. Starf., p. 172, cut.
 1846. *Toxopneustes Drobachensis*, Agassiz & Desor, Catal. raisonn.,
 Ann. Sci. Nat., (3) vi., p. 367.
 1848. *Echinometra Dröbachensis*, Gray, Brit. Rad., p. 4.
 1868. *Toxopneustes pictus*, Norman, Last Rep. Shetland Dredgings,
 p. 314.
 1872. *Strongylocentrotus Dröbachensis*, Agassiz, Rev. Echin., pp. 162,
 277, pl. iva, figs. 2, 3, 6;
 pl. vi., fig. 9; pls. ix., x.,
 xxiv., figs. 15-24; pl. xxvii.,
 figs. 1-5; pl. xxxviii., figs.
 13, 14.
 1874. *Toxopneustes pictus*, Lovén, Études, pl. x., figs. 84, 85 (peri-
 stome, spheridium); pl. xvii. (test);
 pl. xxi., figs. 171-176 (apex).
 1883. ,, ,, Lovén, Pourtalesia, pl. xi., figs. 112-115
 (pedicel).

Diagnosis.

Test somewhat pentagonal; five pairs of pores in each set from the mouth to the anus; four or five primary spines on each interambulacral plate, but little larger than the secondaries.

Distribution.

British Seas.—Off Lerwick, 10 fms; off Scalloway; off Stromness (FORBES, 1). Shetland, 4 fms. (FORBES, 2). Bressay Sound (NORMAN, 3). Sandwich Bay (Brit. Mus.). S.-W. of Shetland, 6-75 fms. (PEARCEY). N. and W. of Scotland, 125-640 fms. (THOMSON, 1). Orkneys, 7 fms. (FORBES, 2). Off Montrose, 53 fms. (BELL, 1). St Andrews (M'INTOSH). Firth of Forth, 30 fms. (LESLIE and HERDMAN). Holy Isle (Coll. NORMAN); Northumberland and Durham (Coll. NORMAN; HODGE). Off Coquet I., 25-30 fms. (BRADY). North Sea (Brit. Mus.). Fal-mouth (COCKS).

Other Localities.—Arctic Regions (Brit. Mus.). Spitzbergen, Kara Sea, Iceland (Copenhagen Mus.). Greenland (Brit. Mus.; Copenhagen Mus.; Coll. NORMAN). Norway (SARS; GRIEG; Copenhagen Mus.; Brit. Mus.; Coll. NORMAN). Denmark (Coll. NORMAN). Roscoff (GRUBE). Labrador (Brit. Mus.; Copenhagen Mus.). East Coast of U.S.A. (Copenhagen Mus.; Manchester Mus.; Coll. NORMAN); 1-640 fms. (VERRILL); 53 fms. (AGASSIZ, 5). Off Halifax, Nova Scotia, "Challenger," Sts. 48 and 49, 51 and 83 fms. (AGASSIZ, 3). North Pacific (AGASSIZ, 5).

1859. *Sphærechinus esculentus*, Bronn, Klass. u. Ord. d. Thierreichs,
p. 337, pl. xxxvii., figs. 1-3, 5-14,
and 16-19; pl. xxxix. fig. 6.
1863. „ *granularis*, Agassiz, Bull. Mus. Comp. Zool., i.,
p. 23.
1884. *Sphærechinus granularis*, Carus, Prodr. faun. Medit., i., p. 100.

Diagnosis.

Test very little depressed; flattened below; anal system large, with few large plates; spines strong, short, crowded, violet, with a more or less extensive white tip, or altogether white.

Distribution.

British Seas.—Guernsey (Coll. NORMAN). Jersey (KÖHLER; Manchester Mus.).

Other Localities.—S.-W. France (FISCHER). Portugal (Brit. Mus.). Spain (Coll. NORMAN, pres. by Don Pedro Antiga). Mediterranean (Copenhagen Mus.; Coll. NORMAN; CARUS). Madeira, Cape Verde Is. (Brit. Mus.). Azores (Brit. Mus.; Copenhagen Mus.). “Challenger,” St. 75, 50-90 fms. (AGASSIZ, 3).

ECHINIDÆ, Agassiz.

Test regular; tubercles imperforate; spines for the most part short and subulate; pores in sets of three pairs.

6. *Echinus*, Linné.

Test spheroidal; primary tubercles imperforate, subequal, in two series both in ambulacra and interambulacra; other tubercles small and scattered irregularly; spines of one form.

10. *Echinus esculentus*, Linné.

1758. *Echinus esculentus*, Linné, Syst. nat., ed. x., p. 663.
1841. „ *sphæra*, Forbes, Brit. Starf., p. 149, cut.
1844. „ *esculentus*, Düben & Koren, Öfvers. Skand. Echin.,
p. 264.
1872. „ „ Agassiz, Rev. Echin., pp. 122, 491.
1887. „ „ Lovén, Echin. Mus. Ludov. Ulric., p. 61.

Diagnosis.

Test usually of a pink or reddish tinge; spines usually pink or white, with one or two violet rings, more rarely white; primary spines scarcely longer than secondary, giving the appearance of being evenly covered with short subequal spines; in the denuded test the twenty meridians of primary pores are scarcely apparent.

Distribution.

Irish Sea—"In all the shores of Britain and Ireland."
 "From the Atlantic zone to that of Corallines" (FORBES, 1).
 SHETLAND, about in the Coralline zone NORMAN, 1); 15-30 fms.
 FROTHINGHAM, 1. (Between 10-15 fms. Hebrides NORMAN, 2). Hebrides,
 40 fms. N-W Scotland 15-20 fms. FORBES, 2). Off Montrose,
 25 fms. off Aberdeen 4 fms. BELL, 1). Upper Loch Torridon
 BELL, 1). Loch Ewe 15-20 fms.: Yberdory, 30 fms.; 4 miles
 S-E of Sanna 3-35 fms.: between Great Cumbrae and Wemyss
 Sound, 3-40 fms.: off Ailsa Craig, 24 fms.; Kilbrennan
 Sound, 1-2 fms.; Loch Fyne, 5 fms. Brit. Mus., presented
 by JAMES MITCHELL. Outer Firth, 20-40 fms. (HENDERSON).
 Inchmurrich Firth, 17-20 fms.; Loch Fyne, 30-80 fms.; Loch
 Striven, 40 fms.; Durness Bay, 3-40 fms.; Loch Goll and
 Firth Loch Long, 30 fms.; Gairloch, 20 fms. (HOYLE, 2).
 BUCHANAN, GLENFORTH, LARLING Bay HELLMAN, 1). St Andrews
 N. LINDSEY. Anstruther Bay FLEMING and DAWSON). Firth of
 FORTH, FORTH, LARLING and HELLMAN: Brit. Mus.). Off Mull of
 Galloway, 10-15 fms. THOMPSON, 1). Isle of Man, 7-20 fms.
 FORBES, 2). Firth Eire HELLMAN, 1). low water; off Puffin L.
 HELLMAN, 2). Off Holy I. BRANT. Coast of Northumberland
 and Durham, HUNT. DUNELM Bay KIRKMAN). Brehaven
 HATTON, 1). Galloway and Irvine Bay, also 20-25 fms.
 FORTH and HALL, 20-25 fms. FORBES, 2). South Devon
 and Galloway, HUNT. Mizen's Bay TRECHLES). Polperro
 Brit. Mus.). Falmouth Brit. Mus.; COCKS). Torbay (PARFITT).
 Plymouth PARFITT; HART; COLL. NORMAN¹). All coasts of
 Ireland THOMPSON, 2). S-W. Ireland, 50-110 fms. (BELL, 3, 4).
Other Localities—Svalbard, Iceland, Norway, Sweden
 Copenhagen Mus.; Norway SARR; M-ANDREW and BARRETT,
 COLL. COLL. NORMAN. Denmark LITKEN. Feroes (Copen-
 hagen Mus.). Holland WEINLAND. Holland (MAITLAND).
 Coast of France FINCH. BARBON. Coast of Spain or Por-
 tugal NAYLOR Brit. Mus.; Mediterranean CARUS; Brit. Mus.).
Remarks—Var. *torquosa* or *norman*. "It is very high."
 North of Umeå 100 fms. NORMAN, 1).
 Var. *a*. With red and red spines. Off Scarborough (Coll.
 NORMAN).
 Var. *b*. With brownish-red spines. Norway (Coll. NORMAN).
 Var. *c*. "A marked variety with a tall narrow test occurred
¹ Specimens 20 ins. equatorial circumference, 18½ ins. polar circumference.

in deep water off the Færøes" (THOMPSON, 2). Perhaps this is var. *tenuispina*, NORMAN.

Abnormal example (BATE).

11. *Echinus acutus*, Lamarck.

1816. *Echinus acutus*, Lamarck, Hist. anim. a. vert., iii., p. 45.
 1828. „ *miliaris*, Fleming, Brit. Anim., p. 478 (*nee* Müller).
 1841. „ *Flemingii*, Forbes, Brit. Starf., p. 164, cut.
 1844. „ „ Düben & Koren, Skand. Echin., p. 266,
 pl. ix., figs. 31, 32.
 1872. „ *acutus*, A. Agassiz, Rev. Echin., pp. 121, 489.
 1884. „ „ Carus, Prodr. faun. Medit., p. 100.

Diagnosis.

Test subconical; principal tubercle in each plate very conspicuous and surrounded by secondary ones both in ambulacral and interambulacral plates; secondary tubercles more numerous in the oral than the aboral surface; primary spines much fewer than secondary, and nearly three times as long; colour yellowish, often with reddish bands; spines white, with a dull green band, changing into red at the base.

Distribution.

British Seas.—Shetland, Youghal, S.-W. Ireland (FORBES, 1). Færoe Channel, 400 fms. ("Porcupine" Exp., *fide* AGASSIZ, 2). North and West of Shetland (THOMPSON, 1). Shetland, Outer Haaf (NORMAN, 1¹). Off N. Rona, "Knight Errant," St. 3, 53 fms. (AGASSIZ, 4). Hebrides (NORMAN¹). St Andrews (M'INTOSH). Tynemouth (Brit. Mus.). S. of Ireland, 100 fms. ("Porcupine" Exp., *fide* AGASSIZ, 2). S.-W. Ireland, 55-500 fms. (BELL, 3). S. of Ireland (THOMPSON, 2). S.-W. of Ireland, 70 fms. (BELL, 4). Mount's Bay (TREGELLES). Cornwall and Devon (BATE). Falmouth (COCKS; Brit. Mus.). Torquay (PARFITT). Plymouth (HEAPE; Coll. NORMAN¹). Weymouth (Brit. Mus.). Budleigh-Salterton (Coll. NORMAN).

Other Localities.—Norway (SARS; Brit. Mus.; Coll. NORMAN; Copenhagen Mus.; Manchester Mus.; GRIEG). Holland (MAITLAND). France (FISCHER). Cape Sagres ("Porcupine" Exp., *fide* AGASSIZ, 2). Mediterranean (LUDWIG; CARUS; Brit. Mus.). W. Indies (AGASSIZ, 1). S. Pacific, 520 fms. (Brit. Mus.). Off Halifax, "Challenger," St. 46, 1350 fms. Off Kermadec Island, "Challenger," St. 170, 630 fms. Off Ascension, "Challenger," St. 343, 425 fms. (AGASSIZ, 3).

¹ Specimen, 15 $\frac{1}{2}$ ins. in equatorial, 13 $\frac{1}{4}$ ins. in polar circumference.

12. *Echinus melo*, Lamarck.

1816. *Echinus melo*, Lamarck, Hist. anim. s. vert., iii., p. 45.
 1834. „ „ Blainville, Man. d'Actinol., p. 226, pl. xx.,
 figs. 3, 3a, 3b.
 1872-3. „ „ Agassiz, Rev. Echin., pp. 124, 493.
 1884. „ „ Carus, Prodr. faun. Medit., i., p. 100.

Diagnosis.

Test globular; actinal opening smaller than in *E. acutus*; greenish-yellow in colour, red and pink in *E. acutus*; principal row of vertical primary tubercles small; more secondaries than in *E. acutus*; horizontal sutures bare both in ambulacral and interambulacral area, forming a lozenge-shaped pattern lighter than the main colour of the test; primary spines more closely striated than in *E. acutus*, and genital openings not so near the edge of the plates; median vertical sutures of ambulacral and interambulacral spaces forming a distinct double zigzag line, diminishing in breadth towards either pole.

Distribution.

British Seas.—Off North Rona, “Knight Errant,” St. 3, 53 fms (AGASSIZ, 4). Cornwall (FORBES, 3).

Other Localities.—Coast of France (BARROIS). Off Portugal (THOMSON, 2). Mediterranean (LUDWIG; CARUS; Manchester Mus.; Coll. NORMAN). Canaries, Cape Verde Is. (AGASSIZ, 5).

This species is very near *E. acutus*, and it is very doubtful whether it is more than a globular variety of this latter. It is very desirable that further evidence should be obtained as to its occurrence in British waters.

13. *Echinus elegans*, Dübén & Koren.

1844. *Echinus elegans*, Dübén & Koren, Skand. Echin., p. 272, pl. x., figs. 40-42.
 1872. „ „ Agassiz, Rev. Echin., pp. 122, 491, pl. viia., fig. 4.
 1874. „ „ WYV. Thomson, “Porcupine” Echin., Phil. Trans., p. 744, pl. lxviii., figs. 11-13.
 1889. „ „ Bell, Ann. and Mag. Nat. Hist., (6) iv., pp. 441, 442, pl. xix., figs. 2, 3.

Diagnosis.

Test hemispherical, reddish, with ten red stripes extending from the apex to the equator; twenty very distinct series of primary tubercles, not interrupted; spines very long, acute

brilliant red, sometimes with white tips; primaries two or three times as long as secondaries, which do not increase either in size or number towards the peristome.

Distribution.

British Seas.—Off the Butt of Lewis, warm area, "Lightning," St. 12, 530 fms. (THOMSON, 1). 25 miles N.-E. of Unst, Shetland, 95 fms. (Coll. NORMAN).¹ N. and W. of Scotland, 125-640 fms. (THOMSON, 1). East coast of Scotland (Brit. Mus.). Off Montrose, 42 fms.; off Peterhead, 48-60 fms. (BELL, 1). N.-W. of Ireland, "Porcupine" (1869), St. 25, 164 fms. (Copenhagen Mus.). 40 miles off Valentia, 110 fms. (THOMSON, 1; Coll. NORMAN). S.-W. of Ireland, 250 fms. (BELL, 3).

Other Localities.—Norway, 150-250 fms. (SARS; Copenhagen Mus.; Coll. NORMAN). Cape Sagres, 80 fms., "Porcupine" Exp. (*vide* AGASSIZ, 2). Mediterranean (Brit. Mus.). Tristan da Cunha, "Challenger," St. 135F, 1100 fms. S. of Halifax, Nova Scotia, "Challenger," St. 46, 1350 fms. (AGASSIZ, 3). Coast of U.S.A., 858-888 fms. (VERRILL). Off Admiralty Is., "Challenger," St. 219, 150 fms. (AGASSIZ, 3).

Variety.—Dr Norman's collection contains what appears to be an albino variety of this species.

14. *Echinus microstoma*, Wyville Thomson.

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|-------|-----------------------------|--|
| 1874. | <i>Echinus microstoma</i> , | Wyv. Thomson, "Porcupine" Echin., |
| | | p. 744, pl. lxviii., figs. 1-10. |
| 1886. | " " | Haddon, Rep. S.-W. Ireland, P. R. Irish |
| | | Acad., (2) iv., p. 620. |
| 1889. | " " | Bell, Ann. and Mag. Nat. Hist., (6) iv., |
| | | p. 440, pl. xix., fig. 1. |

Diagnosis.

At the present moment I cannot regard this species as other than most unsatisfactory. Sir Wyville Thomson's diagnosis is merely provisional, and his figure "by no means good." Professor Bell (*loc. cit.*) has given us a new figure, but has not ventured upon any differential diagnosis. I have had the opportunity of examining the specimen which Bell (*loc. cit.*, p. 445) says "agrees in all essential characters" with the one which he figures. It is certainly quite easy to distinguish that specimen from all the

¹ This was the first example known to have been obtained in British seas. It has been identified by comparison with Norwegian specimens.

examples of *E. elegans* which I have seen. The colour is a very dull red, diffused over the test, and not arranged in definite bands; the spines are white, and those on the abactinal surface have a dull greenish band at the base, recalling the spines of *E. acutus*. How far these characters would serve to distinguish the species I will not venture to say. According to Bell's measurements the mouth in *E. microstomus* seems to be about one-fourth the diameter of the test, whilst in *E. elegans* it is on the average nearly one-third. According to Sir Wyville's figures the jaws present some points of distinction, though these can hardly be of general utility for practical discrimination.

Distribution.

British Seas.—Off west coast of Scotland and Ireland, 150-400 fms. (THOMSON, 2). Off the mouth of the English Channel, "Porcupine" (1870), St. 1, 567 fms., and St. 3, 690 fms. (THOMSON, 1). Off Valentia (Coll. NORMAN, from "Porcupine" Exp.) S.W. Ireland, 110-500 fms. (BELL, 3).

Other Localities.—Bay of Biscay (NORMAN, 3).

13. *Echinus norvegicus*, Dübén & Koren.

1844. *Echinus norvegicus*, Dübén & Koren, Skand. Echin., p. 268, pl. ix., figs. 33-39.

1872 Agassiz, Rev. Echin., pp. 125, 296, 496, pl. vii., fig. 4.

Diagnosis.

Test usually not exceeding 15 mm. (0.6 in.) in diameter (largest recorded 30 mm. = 2 in.); flattened conical in the larger specimens; five red broad bands or blotches surround the anus; rarely some of all these blotches are divided, doubling the number of red lines; primary tubercles in ten conspicuous rows in the larger specimens; some of the primary tubercles have often disappeared in the aboral surface; spines of uniform colour; primaries much more than half the diameter of the test in specimens of average size.

Distribution.

British Seas.—Off the Butt of Lewis, warm area, "Lightning," St. 12, 330 fms. Firth of Channel, cold area, "Porcupine" (1869), Sta. 62 on 123-640 fms. (THOMSON, 1). "Knight Errant," St. 1, 33 fms., St. 7, 330 fms. (AGASSIZ, 4). Shetland, 40-100 fms. (PICKARD, 2). Outer Skerries Haaf, off Whalsey Lighthouse, 70 fms.; Vest Haaf St Magnus Bay (NORMAN, 1). E. of Shetland,

"Porcupine" (1869), Sts. 67-70, 64-75 fms. (THOMSON,¹ 1). W. of Shetland, "Porcupine" (1869), St. 71, 103 fms. (Copenhagen Mus.). W. and S. of Shetland, 6-85 fms. (PEARCEY). Off N. Rona, "Knight Errant," St. 3, 53 fms. (AGASSIZ, 4). Off Cape Wrath, 300 fms. ("Porcupine" Exp., *vide* AGASSIZ, 2). North Sea (Brit. Mus.). W. of Ireland, "Porcupine" (1869), St. 17, 1230 fms. S.-W. of Ireland, 400 fms. (BELL, 4). Off Valentia, St. 2, 808 fms. Off the mouth of the English Channel, "Porcupine" (1870), St. 3, 690 fms. (THOMSON, 1).

Other Localities.—Norway, 80-450 fms. (SARS; Copenhagen Mus.; Coll. NORMAN; GRIEG). Coast of U.S.A., 888-1497 fms. (VERRILL); "very common in 1242 fms." (AGASSIZ, 5). Florida Gulf Stream, 195 fms. (POURTALES, *vide* AGASSIZ, 2). S. of Halifax, Nova Scotia, "Challenger," Sts. 46 and 47, 1350 and 1340 fms. Off Japan, Sts. 232 and 235, 345 and 565 fms. Off Patagonia, St. 308, 175 fms. (AGASSIZ, 3).

Variety.—Var. *rarisipina*, Sars, 40 miles off Valentia, 110 fms. (THOMSON, 1; Coll. NORMAN).

16. *Echinus miliaris*, P. L. S. Müller.

- 1771. *Echinus miliaris*, P. L. S. Müller, in Kuorr, Delic. nat. select., pl. D.
- 1841. ,, ,, Forbes, Brit. Starf., p. 161, cut.
- 1844. ,, *virens*, Düben & Koren, Skand. Echin., p. 274, pl. x., figs. 43-45.
- 1872. ,, *miliaris*, Agassiz, Rev. Echin., pp. 125, 495, pl. xxv., fig. 11.

Diagnosis.

Test reddish, with yellow tubercles; primaries much larger than secondaries, and forming twenty prominent rays on the bare shell; rows of pores much less regular than in *E. esculentus*; primary spines usually with purple tips, or wholly dark green, or dark green with brown tips. The form is more depressed than in most specimens of *E. esculentus*.

Distribution.

British Seas.—Irish Sea, west of Scotland, Orkney, North Ireland, Guernsey (FORBES, 1). Shetland (NORMAN, 1; Brit. Mus.), 15-30 fms. (FORBES, 2). Off Ossa Skerry, 56 fms. (PEARCEY). Orkney (FORBES, 1). N.-W. Scotland, 8-20 fms.; Hebrides, 4-25 fms. (FORBES, 2; NORMAN, 2). Upper Loch Torridon

¹ A specimen from St. 67 is preserved in the Copenhagen Museum.

(HOYLE, 1). Off Montrose, 53 fms. (BELL, 1). Clyde, 40 fms. (FORBES, 2). Off Sana I. [? Sanda], 40 fms. (HYNDMAN), "common from tide marks to the Coralline zone" (HENDERSON). Lamlash Bay (HERDMAN, 1). Loch Goil, 45 fms. (HOYLE, 2). Whiting Bay, Kilbrennan Sound, 10-20 fms. (Brit. Mus.). Rothesay (GRIEVE, 1). St Andrews (M'INTOSH). Firth of Forth (LESLIE and HERDMAN, Brit. Mus.). Northumberland and Durham (HODGE). Off Coquet I. (BRADY). Off Mull of Galloway, 110-140 fms. (THOMPSON, 1). Isle of Man (Brit. Mus.), 7-20 fms. (FORBES, 2). Port Erin; Puffin I., Penmaenmawr (HERDMAN, 3). Ireland, off Bray Head, 23 fms. (HADDON, 1). Dublin Bay (KINAHAN). N. Wales, 7-20 fms. (FORBES, 2). Roundstone (Coll. NORMAN). Off Berehaven, 5-25 fms., Bantry Harbour, 4-6 fms. (HADDON, 2). S. Wales, 12 fms. (FORBES, 2). Ilfracombe (PARFITT). Cornwall and Devon, 7-12 fms. (FORBES, 2). S. Devon and Cornwall (BATE; COUCH). Mount's Bay (TREGELLES). Falmouth (COCKS; Brit. Mus.). Plymouth, Weymouth (Brit. Mus.). Salcombe (Coll. NORMAN). Dorset and Hants, 12-27 fms. (FORBES, 2). St Leonards (Brit. Mus.). Hastings (Coll. NORMAN). Guernsey (FORBES, 1; Coll. NORMAN). Ireland (THOMPSON).

Other Localities.—Iceland, Færoe (Copenhagen Mus.). Norway and Sweden (Copenhagen Mus.; M'ANDREW and BARRETT; SÆRS; GRIEG). Denmark (LÜTKEN; Coll. NORMAN; Copenhagen Mus.; Brit. Mus.). Holland (MAITLAND; HORST). France (FISCHER; BARROIS). Spain (Coll. NORMAN, pres. by Don Pedro Antigua). Mediterranean (Brit. Mus.).

CLYPEASTROIDA.

Peristome central; periproct outside the dorso-central system in the posterior interradium; branchiæ external; perignathic girdle disconnected.

FIBULARIIDÆ.

7. *Echinocyamus*, Van Phelsum.

1774. *Echinocyamus*, V. Phelsum (*vide* Agassiz, 2).

Test small, comparatively thick; anus near the mouth on the inferior surface; ambulacra short, wider than the interambulacral spaces; spines short and slender.

17. *Echinocyamus pusillus* (O. F. Müller), Gray.

1776. *Spatagus pusillus*, Müller, Zool. Dan. Prodr., p. 236.
 1777. " " Id., Zool. Dan., p. 18, pl. xci., figs. 5, 6.
 1812. *Echinus pulvinulus*, Pennant, Brit. Zool., 2d ed., p. 140, pl. xxxviii., figs. 1-4.
 1825. *Echinocyamus pusillus*, Gray, Ann. Phil., x., p. 438.
 1841. " " Forbes, Brit. Starf., p. 175, cut.
 1872. " " Agassiz, Rev. Echin., pp. 111, 304, 505, pl. xie, fig. 3; pl. xiii., figs. 1-8.
 1874. " " Lovén, Études, pl. xvi., fig. 139 (apex); pl. xliv. (test).
 1884. " " Carus, Prodr. faun. Medit., p. 101.

Diagnosis.

Test pyriform and depressed, concave below.

Distribution.

British Seas.—"Most parts of the coast of Britain." Ireland, Guernsey (FORBES, 1). Shetland (NORMAN, 1), 50-70 fms. (FORBES, 2). Off Ossa Skerry, 56 fms. (PEARCEY). Off N. Rona, "Knight Errant," St. 3, 53 fms. (AGASSIZ, 4). Orkney, 7-15 fms. (FORBES, 2). Hebrides, 12-90 fms. (NORMAN, 2). Aberdeenshire (GREGOR and DAWSON). Off Aberdeen, 43 fms. (BELL, 1). N.-W. Scotland, 18 fms.; Clyde province, 40 fms. (FORBES, 2). Sound of Mull (Brit. Mus.). Off Sana [? Sanda] I., 40 fms. (HYNDMAN). "Off Cumbræ, Skelmorlie Bank, Lamlash Bay, common, especially on a Nullipore bottom" (HENDERSON). Lamlash Bay (HERDMAN, 1). Firth of Forth (LESLIE and HERDMAN). Northumberland Coast, 25-30 fms. (BRADY). Northumberland and Durham (HODGE; Coll. NORMAN). Off the Mull of Galloway, 50-145 fms. (THOMPSON, 1). Isle of Man, 20 fms.; N. Wales, 7-20 fms. (FORBES, 2). Off Great Ormes Head, 7-8 fms.; Port Erin, 10-20 fms.; Hilbre I., low tide (HERDMAN, 3). Dublin (Coll. NORMAN; KINAHAN). Ireland, N., E., and S. (THOMPSON, 2). Off Bray Head, 23 fms. (HADDON, 1). Bantry Bay (HADDON, 2). Cornwall and Devon (BATE); also 20-25 fms. (FORBES, 2). Mount's Bay (TREGELLES). S. Devon (PARFITT). Plymouth (HEAPE). Guernsey (Coll. NORMAN). Herm (KÖHLER).

Other Localities.—Iceland, Steenstrup (*vide* AGASSIZ, 2). Norway, 300 fms. (SARS; M'ANDREW and BARRETT; GRIEG; Brit. Mus.; Copenhagen Mus.). Denmark (LÜTKEN; Copenhagen Mus.). North Sea (MAITLAND). Holland (HORST). France (BARROIS). Mediterranean (CARUS; LUDWIG; Coll. NORMAN;

Brit. Mus. ; Copenhagen Mus.). Azores (AGASSIZ, 2). Josephine Bank (Stockholm Mus., *vide* AGASSIZ). Florida Reefs, 79-183 fms. (POURTALES, *vide* AGASSIZ, 2). Florida Bank to Antilles, 98-805 fms. (AGASSIZ, 5). Off Brazil, "Challenger," St. 122, 350 fms. (AGASSIZ, 3).

SCUTELLIDÆ, Agassiz.

Test very depressed ; marginal incision and lunules present or absent ; radiating partitions internally.

8. *Arachnoides*, L. Agassiz.

Ambulacral petals diverging ; actinal grooves straight ; no marginal cuts nor lunules.

18. *Arachnoides placenta* (Linné), L. Agassiz.

1758. *Echinus placenta*, Linné, Syst. nat., ed. x., p. 666.
 1841. *Echinarachnius placenta*, Forbes, Brit. Starf., p. 178, cut.
 1841. *Arachnoides placenta*, L. Agassiz, Monogr. Echin., 2^{me} livr., Scutell., p. 94, pl. xxi., figs. 35-42.
 1872. ,, ,, Agassiz, Rev. Echin., pp. 90, 530, pl. xiii^b, figs. 1-4.
 1874. ,, ,, Lovén, Études, pl. viii., figs. 77, 78 (peristome) ; pl. li. (test).

The reasons for doubting the claims of this species to a place in the British fauna have been given above.

Distribution.

British Seas.—Foula, Shetland (FORBES, 1) ?

Other Localities.—"New Zealand, Australia, East India Islands, Burmah" (AGASSIZ, 3).

SPATANGOIDA.

Peristome actinal or frontal ; periproct outside the dorso-central system in the posterior interradium ; neither external branchiæ, jaws, teeth, nor perignathic girdle.

CASSIDULIDÆ, Agassiz.

Mouth central or subcentral, pentagonal, oblique, or elliptical ; no plastrons nor fascioles ; tubercles neither perforate nor crenulate ; pairs of pores crowded close to the peristomial margin, forming, with the single, swollen, and ornamented interradiæ peristomial plates, "a floscelle."

9. *Neolampas*, Agassiz.

1869. *Neolampas*, Agassiz, Bull. Mus. Comp. Zool., i., p. 271.

Test thin, outline pyriform, profile arched, truncate behind; anal opening projecting as a tube; tubercles of uniform size over the whole test; ambulacral system simple, without petals, reduced to single pores between the ambulacral plates.

19. *Neolampas rostellata*, Agassiz.

1869. *Neolampas rostellata*, Agassiz, Bull. Mus. Comp. Zool., i., p. 271.

1872. „ „ Id., Rev. Echin., pp. 147, 340, 551, pl. xvii., figs. 1-12.

1874. „ „ Wyville Thomson, "Porcupine" Echin., Phil. Trans., p. 745, pl. lxi.

1883. „ „ Agassiz, "Blake" Echini, Mem. Mus. Comp. Zool., x., p. 44, pl. xxii.

Diagnosis.

As there is only one species known, the characters given above will suffice for its recognition. I have not seen a specimen of the species.

Distribution.

British Seas.—Off the mouth of the English Channel, "Porcupine" (1870), St. 3, 690 fms. (THOMSON, 2).

Other Localities.—Between Cuba and Florida, 100-125 fms. (AGASSIZ, 1). Florida Bank, 229 fms. (AGASSIZ, 5).

SPATANGIDÆ.

Test ovoid or cordiform, longer than broad, usually with an anterior groove; apical system with four or less perforated plates; anterior ambulacrum differing from the others; periproct in the posterior ambulacrum.

10. *Schizaster*, L. Agassiz.

1835. *Schizaster*, L. Agassiz, Prodr. Echin., Mém. Soc. Neuchatel, for 1834, p. 185.

Test thin, elongate; highest point posterior; lateral ambulacra unequal and depressed; anterior in a deep groove, to which the antero-lateral petals are almost parallel; genital pores two or three; dorsal impression angular, near the petals; lateral impression narrow, descending beneath the anal system, subanal fasciole absent; posterior oral lip prominent, recurved.

20. *Schizaster fragilis* (Düben & Koren), L. Agassiz.

1844. *Brissus fragilis*, Düben & Koren, Skand. Echin., p. 280, pl. x., figs. 47-49.
 1847. *Schizaster fragilis*, L. Agassiz, Catal. raisonné, Ann. Sci. Nat., (3) viii., p. 22.
 1872. „ „ Agassiz, Rev. Echin., pp. 157, 363, 612, pl. xxi., fig. 3; pl. xxvi., fig. 42.
 1874. „ „ Lovén, Études, pl. xii., fig. 102 (apex); pl. xxxi. (test).
 1874. *Tripylus fragilis*, Wyville Thomson, "Porcupine" Echin., Phil. Trans., p. 750.
 1883. *Schizaster fragilis*, Lovén, Pourtalesia, pl. x., fig. 100 (pedicel).
 1883. „ „ Agassiz, "Blake" Echini, Mem. Mus. Comp. Zool., x., p. 74, pl. xxviii., figs. 8-14.

Diagnosis.

Test cordate oval, keeled behind, depressed in front, highest point far back; groove, deep and long; mouth near margin; antero-lateral petals three times as long as posterior; pairs of pores in the anterior ambulacrum thirty-three, in the lateral thirty-five, in the posterior fifteen.

Distribution.

British Seas.—N. and W. of Shetland, 400-500 fms. (THOMSON, 2).

Other Localities.—Off Godthaab, 410 fms., "Valorous" Exp. (NORMAN, 4). Off Halifax, Nova Scotia, "Challenger," St. 49, 83 fms. Off the Cape of Good Hope, St. 142, 150 fms. (AGASSIZ, 3). Norway, 30-150 fms. (SARS; M'ANDREW and BARRETT; Copenhagen Mus.). Gulf of St Lawrence (WHITEAVES). Straits of Florida (POURTALES, *vide* AGASSIZ, 2). U. S. Coast, 37-321 fms. (VERRILL). New England Coast, 71-362 fms., "quite a common species near the 100-fathom line" (AGASSIZ, 5).

11. *Brissopsis*, Agassiz.

1840. *Brissopsis*, Agassiz, Cat. Syst. Ecty., p. 16.

Test thin, more or less ovoid; highest point nearly central; ambulacral petals unequal; anus terminal; subanal fasciole subterminal and complete; dorsal impression complete and surrounding the ambulacral petals.

21. *Brissopsis lyrifera* (Forbes), L. Agassiz.

1841. *Brissus lyrifer*, Forbes, Brit. Starf., p. 187, cut.
 1844. „ „ Düben & Koren, Skand. Echin., p. 280, pl. x., fig. 46.

- Isopsis lyrifera*, Agassiz & Désor, Catal. raisonné, Ann. Sci. Nat., (3) viii., p. 15, pl. xvi., fig. 12.
 „ Agassiz, Rev. Echin., pp. 95, 354, 594, pl. xix., figs. 1-9; pl. xxi., figs. 1, 2; pl. xxxviii., figs. 36-38.
 Lovén, Études, pl. i., fig. 1 (living animal), figs. 10, 17 (spheridia); pl. ii., figs. 27-31 (nervous system); pl. iii., fig. 32 (peristome); pl. xii., figs. 100, 101 (apex); pl. xxxvii. (test).
 „ „ Lovén, Pourtalesia, pl. viii., fig. 66 (monstrous pedicel); pl. ix., figs. 80-90 (pedicel); pl. xii., fig. 143 (peripodium); pl. xix., figs. 223-231 (calyx).
 1883. „ „ Agassiz, "Blake" Echini, Mem. Mus. Comp. Zool., x., p. 69, pl. xxvi., figs. 7-18.
 1884. „ „ Carus, Prodr. faun. Medit., i., p. 103.

Diagnosis.

Test depressed, truncate behind; dorsal impression lyre-shaped and most distinct behind; ambulacral petals depressed; anal system circular; subanal system elliptic, transverse, concave towards the anal system; inferior spiniferous area lanceolate.

Distribution.

British Seas.—Mud, 10-15 fms., in the estuary of the Clyde (FORBES, 1). Færoe Channel, cold area, "Porcupine" (1869), Sts. 62-66, 125-200 fms. (THOMSON, 1). Shetland, 70-90 fms. (FORBES, 2). Unst Haaf, Whalsey Skerries Haaf, St Magnus Bay (NORMAN, 3). Off Samburgh Head, 75 fms. (PEARCEY). Hebrides (NORMAN, 2). N.-W. of Scotland, 30 fms. (FORBES, 2). Aberdeenshire and Moray Firth (M'GREGOR and DAWSON, 1 and 2). Off Montrose, 42 fms. (BELL, 1). Hebrides, 100 fms. (FORBES, 2). Upper Loch Torridon (HOYLE, 1). Loch Duich, 60 fms.; Loch Hourne, 70 fms. (Brit. Mus.). Clyde province, 6-100 fms. (FORBES, 2). Brodick Basin, 50-90 fms.; Kilbrennan Basin, 22-80 fms.; Inchmarnock Basin, 37-104 fms.; Cumbræ Basin, 50 fms.; Dunoon Basin, 30-42 fms. (HOYLE, 2). Off Gourock and Largs (GRIEVE). Lower Loch Fyne, 80 fms. (Brit. Mus.). Off Skate I., Loch Fyne, 105 fms. (HENDERSON). Off Arran and Cumbræ, and Kilbrennan Sound, 22 fms. (Brit. Mus.; HENDERSON). Off Sanda I. and Ailsa Craig (Brit. Mus.). Isle of Man (GRAY). Northumberland and Durham (HODGE; Coll. NORMAN). Off

Tynemouth, 25-35 fms. (BRADY). S.-W. of Ireland (KINAHAN). Off Great Skellig, 70-79 fms.; Berehaven (HADDON, 2). Off Valentia ("Porcupine" Exp., *vide* AGASSIZ, 2). S.-W. Ireland, 55 fms. (BELL, 3). Off the mouth of the English Channel, "Porcupine" (1870), St. 3, 690 fms. (THOMSON, 1). Down to 2090 fms., small specimens (THOMSON, 2).

Other Localities.—Greenland (FORBES). Norway (SARS; Copenhagen Mus.). France, 180 fms. (FISCHER and FOLIN). Cape Breton, Bay of Biscay, 35-80 fms. (Coll. NORMAN). Mediterranean (LUDWIG; CARUS). Cape of Good Hope, shallow water; and "Challenger," Sts. 141 and 142, 98 and 150 fms. (AGASSIZ, 3). Coast of U.S.A., 55-156 fms. (AGASSIZ, 1); 65-1555 fms. (VERBIL). Gulf of Mexico to Antilles, 118-1394 fms. (AGASSIZ, 5).

12. *Spatangus*, Klein.

1734. *Spatangus*, Klein, Nat. disp. Echin., p. 33, pl. xxiii., A, B.

Test cordiform, depressed; broad ambulacral petals; anterior one in a broad more or less deep groove; periproct transverse; subanal fasciole only, including a broad plastron beneath the periproct.

22. *Spatangus purpureus*, O. F. Müller.

1776. *Spatangus purpureus*, O. F. Müller, Zool. Dan. Prodr., p. 236.
 1777. *Echinus lacunosus*, Pennant, Brit. Zool., iv., p. 69, pl. xxxv.
 1777. *Spatangus purpureus*, O. F. Müller, Zool. Dan., pl. v.
 1834. " " Blainville, Man. d'Actinol., p. 202, pl. xiv.
 ... " " Milne Edwards, in Cuvier, Règne anim.,
 pl. xibis, fig. 1; pl. xvii., fig. 2.
 1841. *Spatangus purpurcus*, Forbes, Brit. Starf., p. 182, cut.
 1872. " " Agassiz, Rev. Echin., pp. 158, 565, pl.
 xij., figs. 19-22; pl. xiva, fig. 1; pl.
 xixc, figs. 5, 6; pl. xxvi., figs. 24-27;
 pl. xxxii., figs. 17, 18; pl. xxxiv.,
 figs. 3, 4; pl. xxxvii., fig. 16; pl. xxxviii.,
 figs. 34, 35.
 1874. " " Lovén, Études, pl. i., figs. 20-22; pl. ii.,
 figs. 23-26 (spheridia); pl. xxxvi. (test,
 etc.).
 1883. " " Lovén, Pourtalesia, pl. x., fig. 109
 (pedicel); pl. xi., fig. 145 (peri-
 podium); pl. xviii., figs. 209-219
 (calyx).
 1884. " " Carus, Prodr. faun. Medit., i., p. 102.

Diagnosis.

Test broadly cordiform, truncate behind; posterior petals closed; anterior longer than the posterior; anal impression ovate; subanal broadly reniform, with an incurrent angle below the anal system. On the inferior surface the spineless areas are narrower than the central spiniferous one.

Distribution.

British Seas.—Rare in England, Firth of Forth, Isle of Man, Wicklow, Weymouth (FORBES, 1). ? N.-W. of the Butt of Lewis, "Knight Errant," St. 6, 530 fms. (AGASSIZ, 4). Shetland, down to 100 fms. (NORMAN, 3); 5-80 fms. (FORBES, 2). W. of Shetland, 55-76 fms. (PEARCEY). Off N. Rona, "Knight Errant," St. 3, 53 fms. (AGASSIZ, 4). Orkneys, 5-40 fms. (FORBES, 2). Aberdeenshire (GREGOR and DAWSON). Off Aberdeen, 38-43 fms.; off Peterhead, 58 fms. (BELL, 1). Clyde province, 40 fms. (FORBES, 2). Off Sana [? Sanda] I., 40 fms. (HYNDMAN). Cumbræ Basin, 50 fms.; Upper Loch Fyne, 36 fms.; Dunoon Basin, 40 fms. (HOYLE, 2). Off Cumbræ, Skelmorlie Bank, Lamlash Bay, Garnock Beacon, 35 fms.; Little Cumbræ, low water (HERDMAN). Lamlash Bay (HERDMAN, 2). Kilbrennan Sound, Sanda Sound, 22 fms. (Brit. Mus.). Firth of Forth (LESLIE and HERDMAN). Northumberland and Durham (HODGE; Coll. NORMAN). 50-80 miles E. of Tynemouth, 25-35 fms. (BRADY). Off the Mull of Galloway, 50-140 fms. (THOMPSON, 1). Isle of Man, 20 fms. (FORBES, 2). Port Erin, 15 fms. (HERDMAN, 3). N. Wales, 12 fms. (FORBES, 2). Beaumaris, low water (HERDMAN, 3). Ireland, N. and E. (THOMPSON, 2). Dublin Bay (KINAHAN). Mouth of Bantry Bay, 35-40 fms. (HADDON, 2). S.-W. Ireland, 50-60 fms. (BELL, 3). Devon and Cornwall (BATE; COUCH, 1); 20-25 fms. (FORBES, 2). Mount's Bay (TREGELLES). Plymouth (PARFITT; HEAPE). Weymouth (Coll. NORMAN). Jersey, Herm (KOEHLER). S.-W. of Ireland, 70-400 fms. (BELL, 4).

Other Localities.—Iceland, Bergen, Cattegat (Copenhagen Mus.). Norway (SARS; Coll. NORMAN; M'ANDREW and BARRETT; GRIEG). Denmark (LÜTKEN). Holland (MAITLAND; HORST). France (FISCHER; BARROIS). Portugal (Brit. Mus.; "Porcupine" Exp., *vide* AGASSIZ, 2). Spain (Coll. NORMAN, pres. by Don Pedro Antiga). Mediterranean (LUDWIG; CARUS; Brit. Mus.; Copenhagen Mus.). Off the Azores, "Challenger," St. 75, 450 fms. Off Bermuda, 100 fms. (AGASSIZ, 3).

23. *Spatangus Raschi*, Lovén.

1868. *Spatangus meridionalis*, Norman, Last Rep. Shetland Dredging, p. 315.
 1869. „ *Raschi*, Lovén, Ann. and Mag. Nat. Hist., (4) iv., p. 220.
 1870. „ „ Lovén, Öfvers. k. Vet. Akad. Förh. xxvi. for 1869, p. 733.
 1872. „ „ Agassiz, Rev. Echin., pp. 159, 567, pl. xxv., fig. 35; pl. xxvi., fig. 23.
 1889. „ „ Bell, Ann. and Mag. Nat. Hist., (6) iv., pp. 442-444.

Diagnosis.

In this species the test is more elevated than in the last; the anus is subinferior, and the anal tract small; subanal tract inconspicuous; petals narrower and less depressed than in *S. purpureus*; spines short and slender, and their tubercles correspondingly less conspicuous than in the form just mentioned. On the inferior surface the lateral spineless areas are wider than the central spiniferous one.

Distribution.

British Seas.—W. and N. of Shetland, "Porcupine" (1869) (THOMSON, 1). Shetland (BARRETT; Brit. Mus.); 25-35 miles N.N.W. of Burrafirih Lighthouse, 100-140 fms. (NORMAN, 3). Off St Kilda, 100 fms. (HOYLE, 1). 40 miles off Valentia, "Porcupine" (1869), 110 fms. (THOMSON, 1; Coll. NORMAN). Kerry (Brit. Mus.). 40 miles S.-W. of Ireland, 30-90 fms.; off Great Skelligs, 110-120 fms. (HADDON, 2). S.-W. Ireland, 100-180 fms. (BELL, 3).

Other Localities.—Scandinavia, 200 fms. (RASCH, *vide* AGASSIZ, 2). Azores (Breslau Mus., *vide* AGASSIZ, 2). Portugal (Brit. Mus.). Off the Cape of Good Hope, "Challenger," St. 142, 150 fms.; Agulhas Bank, 100 fms. (AGASSIZ, 3).

13. *Echinocardium*, Gray.

1825. *Echinocardium*, Gray, Ann. Phil., x., p. 430.

Test cordate, thin; ambulacral petals more or less triangular; anterior ambulacrum in a more or less distinct fossa, with small pores; anal system vertically truncate; subanal depression ovato-cordate; terminal, with branches ascending round the anal system; dorsal impression within the ambulacral petals; inferior spines spatulate; the rest slender and silky.

24. *Echinocardium cordatum* (Pennant), Gray.

1777. *Echinus cordatus*, Pennant, Brit. Zool., iv., p. 58, pl. xxxiv., fig. 75.
 1825. *Echinocardium pusillus*, Gray, Ann. Phil., x., p. 430.
 1825. † *Spatangus canaliferus*, Foggo, Edin. Journ. Sci., ii., p. 78.
 1841. *Amphidotus cordatus*, Forbes, Brit. Starf., p. 190, cut.
 1848. *Echinocardium* „ Gray, Brit. Rad., p. 6.
 1872. „ *cordatum*, Agassiz, Rev. Echin., pp. 109, 349, pl. xix., figs. 10-17; pl. xx., figs. 5-7.
 1874. „ „ Lovén, Études, pl. i., figs. 2-7; pl. iii., fig. 38 (spheridia); pl. xii., fig. 107 (apex); pl. xxxix. (test).
 1883. „ „ Lovén, Pourtalesia, pl. viii., figs. 57, 58; pl. xi., figs. 120-126 (pedicels); pl. xii., fig. 148 (peripodium).
 1884. „ „ Carus, Prodr. faun. Medit., p. 102.

Diagnosis.

Test most elevated posteriorly; dorsal ambulacral depressions deep; dorsal impression ovate, pointed behind; the posterior pore row of the antero-lateral series and the anterior of the postero-lateral form an even curve; in the antero-lateral the anterior row has six to nine pairs of pores, the posterior eleven or twelve; post-oral spiniferous space broadly ovate.

Distribution.

British Seas.—“The commonest of all the Heart-Urchins. . . . It abounds in all our sandy bays” (FORBES, 1). Shetland (NORMAN, 3). Off Sumburgh Head, 75 fms. (PEARCEY). Rothesay (GRIEVE). Cumbræ (Coll. NORMAN). Lamlash Bay (HERDMAN, 1). Firth of Clyde, “common in sand at low water, and dredged in sandy ground in shallower water” (HENDERSON). Aberdeenshire (GREGOR and DAWSON). St Andrews (Brit. Mus.). Firth of Forth (LESLIE and HERDMAN; FOGGO?). Northumberland and Durham (HODGE; Coll. NORMAN). Dublin Bay (KINAHAN). Southport (Brit. Mus.). Penmaenmawr to Southport, low water (HERDMAN, 3). Devon (PARFITT). Mount's Bay (TREGELLES). Scilly Is. (Coll. NORMAN; Brit. Mus.). Ireland (THOMPSON, 2). Salcombe, Hastings (Coll. NORMAN). Plymouth (HEAPE). Guernsey (KOEHLER).

Other Localities.—“Found throughout the seas of Europe” (FORBES, 1). Norway (SARS; Copenhagen Mus.; M'ANDREW and BARRETT; GRIEG; Coll. NORMAN). Denmark (LÜTKEN; Copenhagen Mus.). Holland (MAITLAND; HORST). France (FISCHER;

BARROIS). Spain (Coll. NORMAN). Mediterranean (LUDWIG; CARUS; Brit. Mus.). United States Coast (AGASSIZ, 2). Bahia (Mus. Godeffroy, *vide* AGASSIZ, 2).

25. *Echinocardium pennatifidum*, Norman.

- † 1857. *Amphidotus gibbosus*, Barrett, Ann. and Mag. Nat. Hist., (2) xix. p. 32, pl. vii., fig. 2 (*nec* AGASSIZ).
 1868. *Echinocardium pennatifidum*, Norman, Last Rep. Shetland Dredgings, p. 315.
 1872. „ „ Hodge, Cat. Echin. Northumberland and Durham, p. 142, pl. v., figs. 1-5.
 1872. „ „ Agassiz, Rev. Echin., pp. 111, 351, pl. xx., figs. 1, 2.
 1886. „ „ Bell, Ann. and Mag. Nat. Hist., (5) xvii., pp. 516, 517.

Diagnosis.

Test having the general appearance of *E. cordatum*, owing to the point of greatest elevation being posterior, though not so conspicuously as in that form; the ambulacral areas are very slightly depressed; the deep anterior groove of *E. cordatum* being absent; in the antero-lateral petal, the anterior row has four to nine pairs, the posterior thirteen or fourteen pairs of pores; some of the pedicellariæ have jaws expanded towards the tip, round which are six or more denticles. (This character suggested the specific name.)

Distribution.

British Seas.—Shetland, S. of Bressay I., 25 fms. ? (BARRETT). St Magnus Bay (NORMAN, 3). Off North Rona, “Knight Errant,” St. 3, 53 fms. (AGASSIZ, 4). Off Cumbræ (Robertson, *vide* HENDERSON). Off Holy I. (BRADY, 2). Northumberland and Durham (HODGE). Jersey (BELL, 2). Herm (Coll. NORMAN). Scilly Is. (Brit. Mus.; Coll. NORMAN).

Other Localities.—West Indies and Florida, 79-121 fms. (AGASSIZ, 2).

26. *Echinocardium flavescens* (O. F. Müller), Agassiz

1776. *Spatagus flavescens*, O. F. Müller, Zool. Dan. Prodr., p. 236.
 1841. *Amphidotus roseus*, Forbes, Brit. Starf., p. 194, cut.
 1844. „ *ovatus*, Düben & Koren, Skand. Echin., p. 283, pl. x., fig. 50.
 1872. *Echinocardium flavescens*, Agassiz, Rev. Echin., pp. 110, 351, pl. xx., figs. 3, 4.

1874. *Echinocardium flavescens*, Lovén, Etudes, pl. iii., figs. 33-37
(peristome, etc.).
1883. ,, ,, Lovén, Pourtalesia, pl. xi., figs. 127-
130 (pedicels); pl. xv. (anat. juv.);
pl. xvii. (calyx).
1884. ,, ,, Carus, Prodr. faun. Medit., p. 103.

Diagnosis.

Test ovate, most elevated in the middle; ambulacral depressions shallow; dorsal impression escutcheon shaped; the posterior pore-row of the antero-lateral petal forms an angle with the anterior row of the postero-lateral petal; in the antero-lateral petal the anterior row has four or five pairs of pores, the posterior nine or ten; post-oral spiniferous space lanceolate.

Distribution.

British Seas.—Shetland, Leith Sands, St Andrews, Isle of Man, Belfast, Dublin, Youghal, Cornwall (FORBES, 1). Shetland, 40-140 fms. (NORMAN, 1); 15-90 fms. (FORBES, 2). Off N. Rona, "Knight Errant," St. 3, 53 fms. (AGASSIZ, 4). N.-W. of Scotland (FORBES, 2). Off Cape Wrath ("Porcupine" Exp., *fide* AGASSIZ, 2). Orkneys, 35-40 fms.; Hebrides, 7-40 fms. (FORBES, 2). Hebrides (NORMAN, 2). Off Aberdeen (GREGOR and DAWSON). Off Peterhead, 48, 58, and 60 fms.; off Aberdeen, 38 and 40 fms.; off Montrose, 42 and 53 fms. (BELL, 1). Clyde province, 40 fms. (FORBES, 2). "Loch Striven, 30-40 fms.; off Garnock Beacon, 35 fms.; Skelmorlie Bank, 5-16 fms. Not uncommon in deepish water" (HENDERSON). Firth of Forth (LESLIE and HERDMAN). Coast of Durham, "deep water" (Coll. NORMAN). Northumberland and Durham (BRADY, 1; HODGE). Off the Mull of Galloway, 110-140 fms. (THOMPSON, 1). Isle of Man, 20 fms. (FORBES, 2). Port Erin, 15-20 fms. (HERDMAN, 3). N. Wales, 12 fms. (FORBES, 2). Ireland (THOMPSON, 2). Off Great Skellig, 70-79 fms.; mouth of Bantry Bay, 35-40 fms.; Berehaven, 5-25 fms. (HADDON, 2). S. of Ireland ("Porcupine" Exp., *fide* AGASSIZ, 2). Cornwall and Devon (COUCH; PARFITT); 20-25 fms. (FORBES, 2). Herm (KÖHLER).

Other Localities.—Norway (SARS; M'ANDREW and BARRETT; Coll. NORMAN; GRIEG). Denmark (ESCHRICHT; *fide* AGASSIZ, 2). Cape Breton, Bay of Biscay, 35-80 fms. (Coll. NORMAN). France (BARBOIS). Mediterranean (LUDWIG; CARUS). Coast of U.S.A. (AGASSIZ, 2). Off Cape of Good Hope, "Challenger," St. 142, 150 fms. (AGASSIZ, 3).

POURTALESIIDÆ.

14. *Pourtalesia*, Agassiz.

1869. *Pourtalesia*, Agassiz, Bull. Mus. Comp. Zool., i. p. 272.

Test elongate bottle-shaped, thin and transparent; mouth at one extremity, terminal, in a deep groove; anus supramarginal, at the other; posteriorly a process projecting beyond the anus; smaller spines spatulate; four genital openings; ambulacral pores extend as simple rows from apex to mouth.

27. *Pourtalesia miranda*, Agassiz.

1869. *Pourtalesia miranda*, Agassiz, Bull. Mus. Comp. Zool., i., p. 272.

1872. „ „ Id., Rev. Echin., pp. 152, 345, 561, pl. xviii.

Diagnosis.

This species may be distinguished by the superior surface being almost straight as seen from the side, the inferior gently convex; the oral notch is small and narrow.

As above indicated, there is an uncertainty regarding the occurrence of this species in the British area which I have not the means of clearing up. Sir Wyville Thomson says, "Both of the two specimens procured by Mr Gwyn Jeffreys at a depth of 1215 fathoms in the Rockall Channel are immature, and their characters are too undefined for satisfactory description." Agassiz ("Rev. Echin," p. 152) quotes this locality and depth under the habitat of *P. miranda* with a (!), which signifies that he had himself seen the specimens, and satisfied himself regarding their identification. This would seem to indicate that Agassiz regarded the types of *P. phyle* as referable to *P. miranda*. We find, however, that in his "Challenger" Report (p. 138) he still regards *P. phyle* as a valid species, and devotes half a dozen figures to its elucidation, whilst in his distribution table (p. 217) he quotes this locality and depth both for *P. miranda* and *P. phyle*. Is it possible that of the two specimens one belonged to each species?

British Seas.—[Off Rockall, 1215 fms., Shetland ("Porcupine" Exp.), *fide* AGASSIZ.]

Other Localities.—Florida Gulf Stream, 349 fms. (Pourtales, *fide* AGASSIZ, 2). East Coast of U.S.A., off Havana, 242-576 fms. (AGASSIZ, 5).

28. *Pourtalesia jeffreysi*, Wyville Thomson.

1874. *Pourtalesia jeffreysi*, Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 747, pls. lxx., lxxi.

1883. „ „ Lovén, *Pourtalesia*, pls. i.-v.; pl. xii., fig. 149.

Diagnosis.

Comparatively short and stout; the post-anal process short; superior surface evenly arched, sloping gradually downwards from the centre to the anal notch; seen from above the test narrows anteriorly, and the oral notch is comparatively small.

I have not seen a specimen.

Distribution.

British Seas.—Færoe Channel, cold area, "Porcupine" (1869), St. 64, 640 fms. (THOMSON, 1, 2). "Knight Errant," St. 8, 540 fms. (AGASSIZ, 4).

Other Localities.—Bay of Biscay (NORMAN, 5). U. S. Coast, 843-1555 fms. (VERRILL).

29. *Pourtalesia phyale*, Wyville Thomson.

1874. *Pourtalesia phyale*, Wyv. Thomson, "Porcupine" Echin., Phil. Trans., p. 749, pl. lxx. fig. 11.

1881. ,, *phyale*, Agassiz, Rep. "Challenger" Echini, p. 138, pls. xxii., xxia.

Diagnosis.

Comparatively large and compressed laterally; post-anal process long; superior surface very slightly arched, and descending suddenly to the anal notch; seen from above the test at first narrows towards the anterior end, but expands at the extremity by reason of the everted lips of the large triangular oral depression.

Distribution.

British Seas.—S.-W. of Rockall, "Porcupine" (1869), St. 28, 1215 fms. (THOMSON, 1, 2).

Other Localities.—Southern Ocean, "Challenger," St. 156, 1975 fms. (AGASSIZ, 3). Kerguelen, Australia (AGASSIZ, 5).

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INDEX.

	Page		Page
<i>Amphidotus</i> —		Arachnoides, . . .	420
<i>cordatus</i> , . . .	427	<i>placenta</i> , . . .	420
<i>gibbosus</i> , . . .	428	<i>Asthenosoma</i> , . . .	407
<i>ovatus</i> , . . .	428	<i>fenestratum</i> , . . .	408
<i>roscus</i> , . . .	428	<i>hystrix</i> , . . .	407

	Page	Echinus—	Page
Brissopais,	422	miliaris,	417
lyrifera,	422	miliaris,	418
<i>Brissus</i> —		neglectus,	409, 410
fragilis,	422	norvegicus,	400, 416
lyrifera,	422	placenta,	420
<i>Calveria</i> ,	407	pulvinulus,	419
fenestrata,	408	sphaera,	411
hystrix,	407	subangularis,	408
CASSIDULIDÆ,	420	virens,	417
CIDARIDÆ,	403	FIBULARIIDÆ,	418
Cidaris,	403	Neolampas,	421
affinis,	404	rostellata,	421
borealis,	404	Phormosoma,	405
hystrix,	404	petersii,	406
papillata,	404	placenta,	406
purpurata,	405	uranus,	406
CIDAROIDA,	403	Porocidaris,	405
CLYPEASTROIDA,	418	purpurata,	405
DIADEMATOIDA,	405	Pourtalesia,	430
Dorocidaris,	403	jeffreysi,	430
papillata,	404	miranda,	430
<i>Echinarachnius</i> —		phiale,	431
placenta,	420	phyale,	431
ECHINIDÆ,	411	POURTALESIIDÆ,	430
Echinocardium,	426	Schizaster,	421
cordatum,	427	fragilis,	422
flavescens,	428	SCUTELLIDÆ,	420
pennatifidum,	428	<i>Spatagus</i> —	
pusillus,	427	flavescens,	428
Echinocyamus,	418	purpureus,	424
pusillus,	419	pusillus,	419
<i>Echinometra</i> —		SPATANGIDÆ,	421
drobachensis,	409	SPATANGOIDA,	420
ECHINOMETRIDÆ,	408	Spatangus,	424
ECHINOTHURIDÆ,	405	canaliferus,	427
Echinus,	411	meridionalis,	426
acutus,	413	purpureus,	424
cordatus,	427	raschi,	426
drobachensis,	408	Sphærechinus,	410
elegans,	400, 414	esculentus,	411
esculentus,	411	granularis,	410
esculentus,	410	Strongylocentrotus,	408
flamingii,	400, 413	drobachiensis,	408, 410
granularis,	410	lividus,	410
lacunosus,	424	<i>Tacopneustes</i> —	
lithophagus,	410	drobachensis,	409
lividus,	410	pictus,	409
melo,	400, 414	<i>Tripylus</i> —	
microstoma,	415	fragilis,	422

ANNALS OF THE SOCIETY OF SCIENCE AND F. S. WATER NATIONAL
FOR THE IRELANDS IRELAND. F. S. WATER NATIONAL IN THE
NATURAL HISTORY SOCIETY OF GREAT BRITAIN AND IRELAND.
COMMUNICATED BY THE SECRETARY.

Vol. 101. Part 1. 1901.

During the past twelve years, under the auspices of the
NATURAL HISTORY SOCIETY OF GREAT BRITAIN AND IRELAND, a scheme
of systematic and systematic of specimens of the land
and fresh-water mollusks has been very successfully
carried out. The object being the accumulation of carefully-
selected and therefore trustworthy data for ascertaining the
actual geographical range of the British terrestrial mollusks.
Specimens in the number of many thousands have been
submitted to and carefully examined by Mr. J. C. W. Taylor,
F.R.S., of London, President of the Society and in the case of
slugs by Mr. J. C. W. Taylor. A few specimens have in times been
submitted by other members of the Society & City-
appointed members of the Society but the great bulk of the
specimens have been under the personal examination of Mr.
Taylor that which in our has had a wider experience of
most numerous specimens of specimens of the land and fresh-
water mollusks of the British fauna. The essential principle
of the systematic system adopted being the personal
examination of all specimens sent in by competent and City-
appointed persons it is certain that in preparation of the list
of all over will be tending to improve the value of the
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worthy of being used in the list of specimens.
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worthy of being used in the list of specimens.

river-basin division proposed for Scotland by Dr F. Buchanan White is theoretically more scientific, but for practical convenience—quite apart from the very considerable difficulty of adapting it to England and Ireland, and the necessity of having a special map for its explanation—it does not divide Scotland into areas small enough and numerous enough for the purpose of showing detailed distribution.

In pursuance of the system of which I have thus spoken, no less than 28,669 distinct locality-records, each based upon at least one and oftentimes numerous examples, had been authenticated from all parts of the British Isles down to the end of the year 1889.

The object of this communication is to summarise the records that have so far been authenticated for Scotland, to bring before Scottish naturalists an account of the work which is being done, and to endeavour to enlist their sympathies and their active co-operation in completing it in as short a period as practicable. For this purpose is given under the head of each species all the counties for which it has been authenticated by specimens, stating the locality and the name of the person to whom the Society has been indebted for the privilege of inspecting the voucher-specimens. In this respect we are placed under great obligation to the numerous individuals whose names appear in this communication.

The number of records from Scotland has hitherto been comparatively small. Of the total 28,669 records made to the end of 1889, no less than 24,210 were for England and Wales, and only 2187 for Scotland, and still fewer for Ireland. Of course the potential numerical richness in species of an average Scottish county is much inferior to that of an average English county, for climatological and other reasons; but quite apart from this, considerably less attention has been paid to Scottish than to English land and fresh-water Mollusca. This is shown by the average number of *species* given in our books. The 72 counties and vice-counties of England and Wales average no less than 56 species per county, and two of them have actually had 103 and 102 species respectively authenticated for them. The average for the 41 counties of Scotland only reaches 33 species per

county, and there was not at the end of 1889 a single Scottish comital area which (in our Record-Books) had then attained to what was the general English average.

During the present year (1890), however, a marked change has been effected, thanks to the energy and perseverance which my friend Mr William Evans, the hon. secretary of the Royal Physical Society, has shown in collecting (and causing to be collected) shells in various parts of Scotland for the express purpose of rendering this paper more complete before printing. The records which I owe to him have increased the comital average for Scotland from 21 species (at which it stood in our Record-Books at the end of 1889) to 33 species per county. Through his endeavours too, the number seen for Edinburghshire has reached 72 species, for Haddington 66, and for Fife with Kinross 65. I am also indebted to Mr L. Hinxman of the Geological Survey of Scotland, to Mr Thomas Scott, F.L.S., of Edinburgh, Mr Alex. Shaw of Glasgow, and others, for assistance in this regard during the year 1890. In fact, Scottish naturalists generally have shown a hearty interest in the work of verification and record, and I have to express my heartiest gratification and best thanks for the assistance we have received. Whilst the report was actually passing through the press, I was placed under great obligation to the veteran naturalist, Rev. Dr Gordon, for the privilege of inspecting the shells placed in the Elgin Museum, and which are of peculiar interest as being illustrative of the Moray list which he published in the *Zoologist* in 1854. I have also to express my sincere thanks to my friend Mr Charles Ashford, for assistance in the determination of the specimens. The great majority of the specimens have been verified by Mr Taylor, but Mr Ashford has laid us under deep obligation for assistance rendered at a critical period of over-pressure of work. [This paragraph was written in November 1890.]

As for the remarks upon geographical distribution which the Scottish records suggest, they are more of a negative than of a positive character. Scotland cannot, like Ireland, lay claim to the possession of species not found in England, while, on the other hand, the number of species whose range

in Great Britain falls short of the northern kingdom, or which in Scotland are confined to a few scattered stations, is considerable.

The total number of species—103, excluding *Neritina* and *Paludina*—here recorded for the whole of Scotland does no more than reach the total of 103 recorded for an English vice-county situate so far north as Mid-West Yorkshire, and the total we give includes fourteen additions to the list published in 1873 by Dr White,¹ which is the only general catalogue for Scotland of which we are at present aware. The number he recorded was 93, to which we add two species of *Arion*, one of *Limax*, one of *Amalia*, two of *Testacella*, two of *Zonites*, one of *Helix*, two of *Vertigo*, and three of *Pisidium*.

The distribution of fresh-water shells in Scotland is apparently marked by considerable limitations of northward range. There are not many of them that occur in more than a few scattered stations in the highland counties, and these mainly along the eastern coast, while the proportion of them which reaches the northern coast-line is very small.

The distribution of Scottish land shells is, on the contrary, strikingly wide. There are only about three instances of absolute restriction to or decided predilection for the western side of the kingdom—(*Helix rufescens*, *H. ericetorum*, and *Bulimus acutus*), and but one of apparent predilection for the eastern coast in *Bulimus obscurus*. Restrictions of range in the northward direction are likewise remarkably few, and it is quite possible that they may be more apparent than real, and arising from lack of information. It would be a matter of considerable interest to ascertain in this respect whether *Helix nemoralis*, *H. concinna*, and *H. hispida* find in reality their northern limits in Westernness and Kincardineshire, as would so far appear.

I have now only to say that no attempt to deal with the distribution of varietal forms has been made beyond carefully recording under each species the varieties included in the examples seen by our referees; that it is very desirable that records for such places as Perth, Aberdeen, Queensferry, standing on the borders of counties or vice-counties, should

¹ Scottish Naturalist, Oct. 1873, and Jan. 1874, pp. 163-169, and 205-209.

be confirmed or re-investigated, with a view of determining the rightful vice-county to which each record should be credited, and to say that when I use such terms as "universally distributed" I mean to imply no more than that it occurs, or will most probably occur, within each and all of the vice-comital areas.

Arion ater (L.).

Although this conspicuous and well-known slug is of universal range in Scotland, it has as yet been authenticated for 34 counties only, out of 41.

Dumfries.—Outskirts of Dumfries (W. Evans).

Kirkcudbright.—Castle Douglas (W. Evans).

Wigtown.—Springbank near Stranraer (W. Evans).

Ayr.—Var. *succinea*, coast near Skelmorlie (W.D.R.). Maybole (W. Evans).

Renfrew.—Inverkip Road and Shielhill Glen, near Greenock (W.D.R.).

Lanark.—Cadder Wilderness (W.D.R.).

Peebles.—Walkerburn; Leadburn; Earlyburn; var. *pallescens*, Leadburn and Riddenlees; var. *brunnea*, Leadburn (W.D.R.).

Selkirk.—Thornielee, with var. *alba* (W.D.R.).

Berwick.—Fans (R. Renton). Dryburgh; var. *pallescens*, Cowdenknowes (W.D.R.). Pease Dean near Cockburnspath; var. *nigrescens*, Cockburnspath (W. Evans).

Haddington.—Aberlady (W. Evans).

Edinburgh.—Braidburn, also var. *nigrescens* (W. E. Clarke). Balerno and Bavelaw; Caroline Park near Granton (W. Evans).

Linlithgow.—Forth Bridge (W.D.R.). Linlithgow (W. Evans).

Fife and Kinross.—St Andrews; Crail; Dura Den (W. Evans).

Stirling.—Falls of Inversnaid (B. Hudson). Polmont (W. Evans).

Perth South with Clackmannan.—Callander (A. Somerville).

Perth Mid.—Birnam (W. Evans).

Perth North.—Spittal of Glenshee; Blairgowrie (W. Evans).

Forfar.—Montrose (W. Duncan). Outskirts of Dundee (W. Evans). Var. *marginata*, Den of Airlie (C. B. Plowright).

Kincardine.—Banchory (W. Evans).

Aberdeen South.—Braemar (W. Evans). Drum Woods, Deeside, with var. *nigrescens* (C. B. Plowright).

Aberdeen North.—Haddo House (G. Muirhead).

Easternness.—Inverness (A. Somerville). Kincaig by Kingussie (W. Evans).

Westernness.—Glenborrodale (J. J. Dalgleish).

Main Argyle.—Loch Goil Head (M. E. and G. W. Mellors). Dunoon; Ardenadam; Hunter's Quay (W.D.R.).

Dumbarton.—High Mains near Dumbarton (W.D.R.). Vars. *succinea* and *nigrescens*, Garscadden (Alex. Shaw).

Clyde Isles.—Loch Ranza, Arran; Loch Fad and Baroue, Bute; var. *nigrescens*, Loch Greenan (W.D.R.). Rothesay (T. Scott).

Cantire.—Tarbert (T. Scott), also var. *nigrescens*.

Ebudes S.—Port Charlotte, Islay (W. Evans).

Ebudes Mid.—Iona (A. Somerville and J. E. Somerville).

Sutherland East.—Golspie Burn; Loch Brora; The Mound, etc.; var. *brunnea*, The Mound; var. *plumbea*, Mound Rock and Loch Brora; var. *nigrescens*, Loch Brora and the Blue Rock; var. *albolateralis*, Golspie Burn (W. Baillie).

Sutherland West.—Tongue; Halladaile River (W. Baillie). Stoer; Durness; Erribol (J. E. Somerville).

Caithness.—Dunbeath River (W. Baillie).

Hebrides.—Castlebay, Isle of Barra (J. E. Somerville), also var. *brunnea*.

Shetland.—Colla Firth, Yell Sound (R. W. J. Smart), also var. *brunnea*.

Arion subfuscus (Drap.).

This species does not find a place in Dr White's list, unless indeed the *A. flavus* Müll., of which he makes mention, is to be included wholly or partially in the synonymy of *A. subfuscus*. In all probability *A. subfuscus* will eventually be found to inhabit every Scottish county, though never in numbers so great as those of its congeners.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Castle Douglas (W. Evans).

Lanark.—Cadder Wilderness (W. D. R.).

Peebles.—Leadburn (W. D. R.). Near Peebles; West Linton (W. Evans).

Selkirk.—Holylee (W. D. R.). Var. *cinereofusca*, near Selkirk (W. Evans).

Berwick.—Var. *cinereofusca*, Dryburgh (W. D. R.).

Haddington.—Luffness Links (W. Evans).

Edinburgh.—Braidburn (W. Eagle Clarke). Craiglockhart (W. Evans and W. D. R.). Balerno and Bavelaw; Caroline Park, near Granton (W. Evans).

Linlithgow.—About Linlithgow (W. Evans).

Fife and Kinross.—Otterston; Dura Den (W. Evans).

Perth N.—Blairgowrie (W. Evans).

Kincardine.—Banchory (W. Evans).

Aberdeen S.—Drum Woods, Deeside (C. B. Plowright). Aberdeen Links (W. Evans).

Main Argyle.—Dunoon; Ardenadam (W. D. R.).

Clyde Isles.—Rothesay (T. Scott). Loch Greenan (W. D. R.).

Cantire.—Tarbert (T. Scott).

Ross W.—Ullapool (A. Somerville).

Sutherland E.—Little Ferry, Dornoch; Blue Rock, Brora (W. Baillie).

Arion hortensis Fér.

Range probably universal, and the species may be expected to occur in every county. It frequents cultivated land, and may be recognised by its dark colour and orange or yellow foot-sole.

- Dumfries.**—Outskirts of Dumfries; Moffat (W. Evans).
Kirkcudbright.—Maxwelltown (W. Evans).
Wigtown.—Springbank near Stranraer (W. Evans).
Ayr.—Girvan (W. Evans).
Renfrew.—Shielhill Glen (W.D.R.).
Lanark.—Possil Marsh (W.D.R.).
Peebles.—Earlyburn (W.D.R.). Peebles; West Linton (W. Evans).
Selkirk.—Thornielee (W.D.R.). Selkirk (W. Evans).
Berwick.—Kirklands near Earlstoun (W.D.R.). Near Berwick-on-Tweed (W. Evans).
Haddington.—Falside; Drummorie (W.D.R.). Longniddry (W. Evans).
Edinburgh.—Salisbury Crags; Duddingston Loch; var. *subfusca*, Salisbury Crags (W.D.R.). Dreghorn (W. Evans).
Linlithgow.—South Queensferry (W.D.R.). Linlithgow (W. Evans).
Fife and Kinross.—North Queensferry (W.D.R.). St Andrews; Crail; Dura Den (W. Evans).
Stirling.—Var. *subfusca*, Falls of Inversnaid (B. Hudson). Polmont (W. Evans).
Perth Mid.—Glen Tilt (H. Coates).
Forfar.—Outskirts of Dundee (W. Evans).
Banff.—Macduff (A. Robertson).
Easternness.—Nairn (J. E. Somerville). Glen Feshie (W. Evans).
Westernness.—Glenborrodale (J. J. Dalgleish).
Main Argyle.—Hunter's Quay (W.D.R.). Crinan (J. E. Somerville).
Dumbarton.—High Mains near Dumbarton (W.D.R.). Garscadden (Alex. Shaw).
Clyde Isles.—Ardbeg Point, and Barone, Bute (W.D.R.).
Ebudes N.—Dunvegan, Skye, with var. *subfusca* (W. Evans).
Boss W.—Ullapool (A. Somerville). Loch Broom (J. E. Somerville).
Sutherland E.—Var. *subfusca*, Golspie Burn (W. Baillie).
Sutherland W.—Stoer (J. E. Somerville).
Caithness.—Dunbeath River; also vars. *subfusca* and *rufescens* (W. Baillie).
Hebrides.—Stornoway, Lewis (A. Somerville).
Orkney.—Harray (D. Johnston, per W. Evans).

Arion bourguignati Mab.

This species—only recently distinguished, but of perfectly valid specific rank—is additional to Dr White's list, is common everywhere, and may be expected to occur in every county. It frequents the open fields in preference to cultivated lands and gardens, and may be readily distinguished from *Arion hortensis*, to which it is comparable in size, by the opaque whiteness of its foot-sole.

- Dumfries.**—Outskirts of Dumfries; Moffat (W. Evans).
Kirkcudbright.—Near Maxwelltown (W. Evans).

- Wigtown.**—Springbank near Stranraer (W. Evans).
Ayr.—West Kilbride (A. Somerville). Girvan (W. Evans).
Renfrew.—Shielhill Glen (W.D.R.).
Lanark.—Possil Marsh (W.D.R.).
Peebles.—Walkerburn; Leadburn; Eddleston (W.D.R.). Slipperfield Loch near West Linton (W. Evans).
Selkirk.—Thornielee; Holylee (W.D.R.). Near Selkirk (W. Evans).
Roxburgh.—Eildon Hills (W.D.R.).
Berwick.—Earlston; Dryburgh Abbey (W.D.R.). Berwick; Cockburnspath; Coldingham Loch (W. Evans).
Haddington.—Falside; Drummorie (W.D.R.). Aberlady; Longniddry; Dirleton Common near North Berwick (W. Evans).
Edinburgh.—Salisbury Crags; Levenhall (W.D.R.). Pentlands, above Droghorn; Balerno and Bavelaw (W. Evans).
Linlithgow.—Dalmeny Park (W.D.R.). Linlithgow (W. Evans).
Fife and Kinross.—North Queensferry (W.D.R.). St Andrews; Crail (W. Evans).
Stirling.—Polmont (W. Evans).
Perth South with Clackmannan.—Callander (A. Somerville).
Perth Mid.—Loch Tay side (J. E. Somerville).
Perth N.—Blairgowrie (W. Evans).
Forfar.—Var. *subfusca*, Montrose (W. Duncan).
Kinross.—Banchory (W. Evans).
Aberdeen S.—Drum Woods, Deeside (C. B. Plowright). Aberdeen Links (W. Evans).
Banff.—Tomintoul (L. Hinxman).
Elgin.—Elgin (G. Gordon).
Easternness.—Nairn; Glenurquhart (J. E. Somerville). Inverness (A. Somerville). Glen Feahie; Kinraig by Kingussie (W. Evans).
Westernness.—Glenborrodale (J. J. Dalgleish).
Main Argyle.—Dunoon; Hunter's Quay (W.D.R.).
Dumbarton.—Dumbarton Castle Rock; High Mains (W.D.R.). Garscadden (A. Shaw).
Clyde Isles.—Barone, Bute (W.D.R.).
Ebudes S.—Port Charlotte, Islay (W. Evans).
Ebudes Mid.—Iona (J. E. Somerville).
Ebudes N.—Eigg (W. Evans).
Sutherland E.—Golspie Burn; Mound Rock; Little Ferry, Dornoch; var. *subfusca*, Little Ferry, Dornoch (W. Baillie).
Sutherland W.—Durness; Strathy; Farr (J. E. Somerville).
Hebrides.—Stornoway (C. Ashford). Eye Churchyard, near Stornoway (A. Somerville).
Orkney.—Harray (W. Evans).

Arion minimus Simroth.

This is the latest addition to the list of British slugs, made by Dr R. F. Scharff in the *Journal of Conchology* for October

1890 (published December 11), p. 267. It is a form which is very recognisable when adult by its small size, pale coloration above, yellow foot, and its capability of assuming the hemispherical contraction so well known in *A. ater*. The form is one which I have for some years met with, and been unable to satisfactorily refer to any of our British species, although I did not venture, in the absence of a knowledge of its anatomical characters, to assign to it specific rank. The Elgin specimens have been confirmed as to determination by Dr Simroth, the original describer. The species is a common one, and may be expected to occur in every Scottish county.

Dumfries.—Moffat (W. Evans).

Ayr.—Coast near Skelmorlie (W.D.R.).

Berwick.—Cowdenknowes (W.D.R.).

Haddington.—Dirleton Common near North Berwick (W. Evans).

Edinburgh.—Near Colinton; The Bush near Penicuik (W. Evans).

Linlithgow.—South Queensferry (W.D.R.).

Perth North.—Persie Inn, Glenshee (W. Evans).

Elgin.—Near Elgin (G. Gordon).

Main Argyle.—Hunter's Quay (W.D.R.).

Clyde Isles.—Loch Greenan (W.D.R.).

Ebudes N.—Eigg (W. Evans).

Orkney.—Harray (W. Evans).

***Amalia gagates* (Drap.).**

This species—though as yet reported from three counties only—is likely to be found in other maritime counties, especially in the south and west of Scotland.

Berwick.—Cockburnspath, type and var. (W. Evans).

Edinburgh.—Levenhall, numerous and fine (W.D.R.). Garden at Morningside (W. Evans).

Clyde Isles.—Common about the Aquarium, Rothesay (T. Scott).

***Amalia carinata* (Leach).**

This species also may be expected to turn up in other maritime counties of the south and west than the four from which it has been authenticated.

Renfrew.—Greenock (T. Scott).

Edinburgh.—Meggatland near Edinburgh; Morningside (W. Evans).

Fife and Kinross.—North Queensferry (W.D.R.).

Clyde Isles.—Rothesay, common (T. Scott).

***Limax maximus* "L." Auct.**

This species is probably of general range.

Kirkcudbright.—Near Maxwelltown (W. Evans).

Wigtown.—Var. *fasciata*, Springbank near Stranraer (W. Evans).

Ayr.—Var. *cellaria*, Glen App near Ballantrae (B. Hudson). Var. *fasciata*, Maybole (W. Evans).

Renfrew.—Greenock (Andrew Scott). Vars. *cinerea*, *cellaria*, and *fasciata*, Shielhill Glen (W. D. R.).

Peebles.—Var. *cellaria*, Eddleston; var. *fasciata*, Walkerburn (W. D. R.). Peebles (W. Evans).

Selkirk.—Vars. *ferussaci*, *fasciata*, and *maculata*, Thornielee (W. D. R.). Var. *fasciata*, Selkirk (W. Evans).

Roxburgh.—Var. *cellaria*, near Melrose Abbey (W. D. R.).

Berwick.—Fans near Earlstoun (R. Renton). Cockburnspath (W. Evans).

Haddington.—Drummore; var. *cinerea*, Falside (W. D. R.). Aberlady (W. Evans).

Edinburgh.—Levenhall (W. D. R.). Colinton; Meggatland near Edinburgh; vars. *johnstoni* and *fasciata*, Dreghorn Woods near Colinton; Harmony near Balerno, type and var. *cinerea* (W. Evans).

Fife and Kinross.—Cupar-Fife (T. Scott). Crail; type and var. *fasciata*, St Andrews (W. Evans).

Stirling.—Polmont (W. Evans).

Perth Mid.—Var. *fasciata* approaching *aldrovandi*, Annat Lodge, Perth (H. Coates).

Perth North.—Var. *fasciata*, Bridge of Cally; var. *maculata*, Blairgowrie (W. Evans).

Forfar.—Broughty Ferry (A. Somerville). Montrose, with var. *cellaria* (W. Duncan). Var. *fasciata*, outskirts of Dundee (W. Evans).

Aberdeen N.—Vars. *cinerea* and *fasciata*, Haddo House (G. Muirhead).

Westerns.—Glenborrodale, with var. *cellaria* (J. J. Dalgleish).

Main Argyle.—Vars. *cinerea* and *fasciata*, Dunoon (W. D. R.).

Dumbarton.—Near Forth and Clyde Canal by Maryhill (Alex. Shaw).

Clyde Isles.—Var. *fasciata*, Rothesay (T. Scott).

Islands S.—Var. *fasciata*, Port Charlotte, Islay (W. Evans).

Sutherland E.—Var. *cinerea*, Brora, and Golspie Burn (W. Baillie).

***Limax cinereo-niger* Wolf.**

This is one of the scarcest of the British slugs, having only occurred in but few localities throughout the British Isles, and only singly or in twos and threes anywhere. It may be expected to turn up casually in any part of Scotland. The species may be known from *L. maximus* by its foot being trifasciated longitudinally in colour, the mid band being white and the side ones coloured, by its shield being uniform

in colour and not spotted, and by the comparative coarseness of its sculpture, the largeness of the rugosities giving the slug a superficial resemblance to *Arion ater*.

Forfar.—Den of Airlie, one (C. B. Plowright).

Easternness.—Nethy Bridge, one, July 1887 (J. E. Somerville).

Sutherland E.—The Blue Rock near Loch Brora, etc., several times (W. Baillie).

***Limax arborum* B.-Ch.**

This is the species which Dr White calls *L. marginatus*. It is probably universal in its range in Scotland, and should be found not uncommonly in every county.

Peebles.—Cademuir near Peebles (W. Evans).

Selkirk.—Var. *memorosa*, near Selkirk (W. Evans).

Berwick.—Fans near Earlstoun (R. Renton). Var. *memorosa*, Coldingham (W. Evans).

Haddington.—Aberlady; var. *alpestris*, North Berwick Law (W. Evans).

Edinburgh.—Dreghorn near Colinton; Balerno and Bavelaw, with var. *memorosa*; Caroline Park near Granton (W. Evans).

Fife and Kinross.—Var. *memorosa*, St Andrews Bay (E. E. Prince). St Andrews (W. Evans).

Stirling.—Polmont (W. Evans).

Perth Mid.—Glen Tilt (H. Coates).

Perth North.—Var. *alpestris*, Blairgowrie (W. Evans).

Kincardine.—Var. *memorosa*, Banchory (W. Evans).

Aberdeen N.—Var. *memorosa*, Haddo House (G. Muirhead).

Easternness.—Kincraig by Kingussie (W. Evans).

Sutherland E.—Loch Brora; Golspie Burn; the Blue Rock near Loch Brora; rock south of the Mound (W. Baillie).

Caithness.—Dunbeath River (W. Baillie).

***Limax flavus* L.**

This species—restricted to cellars and the vicinity of human habitations—has only been authenticated from four counties, but should be looked for in all towns and large villages.

Renfrew.—Greenock, abundant at sugar refineries, with var. *grisea* (T. Scott).

Edinburgh.—Gardens, Edinburgh (J. M'Murtrie).

Fife and Kinross.—Crail (W. Evans).

Elgin.—South College, Elgin (G. Gordon).

Agriolimax agrestis (L.).

This is the common field slug, which is an agricultural pest throughout the British Isles, and should be found to occur everywhere. We have seen it from at least one locality in each of the forty-one Scottish counties. It is at once distinguishable from every other slug by its milk-white slime.

Dumfries.—The Grey Mare's Tail (J. Madison). Type and var. *sylvatica*, outskirts of Dumfries; Moffat (W. Evans).

Kirkcudbright.—Near Maxwelltown (W. Evans).

Wigtown.—Vars. *sylvatica* and *nigra*, Springbank near Stranraer (W. Evans).

Ayr.—West Kilbride (A. Somerville). Largs (G. W. Mellors). Skelmorlie (W. D. R.). Var. *sylvatica*, Girvan (W. Evans).

Renfrew.—Greenock, with var. *sylvatica* (A. Scott). Shielhill Glen (W. D. R.).

Lanark.—Var. *albida*, Cadder Wilderness (W. D. R.).

Peebles.—Leadburn and Walkerburn; var. *sylvatica*, Walkerburn (W. D. R.). Var. *sylvatica*, West Linton (W. Evans).

Selkirk.—Thornielee and Holylee; var. *sylvatica*, Thornielee (W. D. R.). Var. *sylvatica*, Selkirk (W. Evans).

Roxburgh.—Eildon Hills; Melrose Abbey; Leader Water side; vars. *sylvatica* and *tristis* also in the last-named locality (W. D. R.).

Berwick.—Fans near Earlstoun (R. Renton). Dryburgh; Earlstoun; Redpath; Kirklands; var. *sylvatica* at Cowdenknowes (W. D. R.). Vars. *reticulata*, *sylvatica*, and *tristis* at Fans (R. Renton). Type and var. *obscura*, Cockburnspath; Berwick, with var. *sylvatica*; var. *sylvatica*, near Coldingham Loch (W. Evans).

Haddington.—Drummore and Falside (W. D. R.). Longniddry; vars. *nigra* and *sylvatica*, Dirleton Common, near North Berwick (W. Evans).

Edinburgh.—Duddingston; Levenhall; Wallyford (W. D. R.). Braidburn (W. Eagle Clarke). Var. *sylvatica*, Balerno and Bavelaw (W. Evans).

Linlithgow.—Near Cramond Bridge; South Queensferry (W. D. R.). Linlithgow (W. Evans).

Fife and Kinross.—North Queensferry, with var. *sylvatica* (W. D. R.). St Andrews Bay (E. E. Prince). Dura Den; St Andrews; Crail (W. Evans).

Stirling.—Var. *sylvatica*, Polmont (W. Evans).

Perth S. with Clackmannan.—Var. *reticulata*, Callander (A. Somerville).

Perth Mid.—Var. *sylvatica*, Loch Tay side (J. E. Somerville).

Perth North.—Blairgowrie (W. Evans).

Forfar.—Montrose, with vars. *rufescens*, *sylvatica*, and *filans* (W. Duncan). Den of Airlie (C. B. Plowright). Outskirts of Dundee (W. Evans).

Kincardine.—Banchory (W. Evans).

Aberdeen S.—Drum Woods, Deeside (C. B. Plowright). Aberdeen Links (W. Evans).

Aberdeen N.—Haddo House, with var. *sylvatica* (G. Muirhead). Peterhead (J. Manson).

Banff.—Var. *sylvatica*, Tomintoul (L. Hinxman). Macduff (A. Robertson).

Elgin.—Var. *sylvatica*, Elgin (G. Gordon).

Easternness.—Nairn; var. *sylvatica*, Nairn and Glenurquhart (J. E. Somerville). Glen Feshie, and Kincaig by Kingussie (W. Evans).

Westernness.—Glenborrodale, with var. *sylvatica* (J. J. Dalgleish).

Main Argyle.—Dunoon; Glen Morag; Ardenadam; Hunter's Quay; var. *sylvatica*, Hunter's Quay, Dunoon, and Glen Morag (W.D.R.). The var. at Crinan, and at Beregonium, an ancient capital of Dalriad Scots, Benderloch, between Lochs Etive and Creran (J. E. Somerville).

Dumbarton.—High Mains near Dumbarton; var. *sylvatica*, High Mains and Crosslet near Dumbarton (W.D.R.).

Clyde Isles.—Rothesay (T. Scott). Loch Greenan and Barone, Bute (W.D.R.)

Cantire.—Tarbert (T. Scott).

Ebudes S.—Var. *sylvatica*, Port Charlotte, Islay (W. Evans).

Ebudes Mid.—Iona (A. Somerville). Var. *sylvatica*, Iona (J. E. Somerville).

Ebudes N.—Dunvegan, Skye, with var. *sylvatica*; Eigg (W. Evans).

Ross W.—Ullapool (A. Somerville). Gairloch, sea-coast; var. *sylvatica*, Loch Carron (J. E. Somerville).

Ross E.—Invergordon (J. E. Somerville).

Sutherland E.—Golspie Burn; Mound Rock; var. *albida*, Golspie Burn; var. *sylvatica*, rock above Loch Brora; the Blue Rock; Mound Rock; var. *tristis*, Mound Rock; var. *sylvatica*, Little Ferry, Dornoch (W. Baillie).

Sutherland West.—Halladaile River (W. Baillie). Stoer; Strathy; Farr; var. *sylvatica*, Durness and Erribol (J. E. Somerville).

Caithness.—Var. *sylvatica*, Dunbeath River (W. Baillie).

Hebrides.—Stornoway, Lewis (A. Somerville).

Orkney.—Harray, with var. *sylvatica* (D. Johnston, per W. Evans).

Shetland.—Type and var. *sylvatica*, Unst; Fetlar; and Mainland (R. W. J. Smart).

***Agriolimax lævis* (Müll.).**

There is but little doubt that this species—which is our smallest slug, and frequents moist situations—will be found in many more Scottish counties than the sixteen from which specimens have been seen by our referees. It is a very active, lively little creature, and may be known by the uniformity of its colour (brown both on the foot and above), its predilection for marshy spots, and its great activity.

Dumfries.—Moffat (W. Evans).

Renfrew.—Near old castle, Inverkip Road, Greenock (W.D.R.).

Peebles.—Slipperfield Loch near West Linton; near Peebles (W. Evans).

Haddington.—Luffness Marshes; Quarry near Gullane (W. Evans).

Edinburgh.—Pentlands, between Hillend and Boghall; also between Bavelaw Castle and Loganlee; plantation above Dregthorn; Balerno; Kirknewton; Roslin; Dalhousie; The Bush near Penicuik (W. Evans).

Linlithgow.—Philpstoun Loch (W. Evans).

Fife and Kinross.—St Andrews; Dura Den; Tentsmuir; Otterston (W. Evans).

Perth M.—Loch of Clunie, between Blairgowrie and Dunkeld (W. Evans).

Aberdeen S.—Cluny Pass summit (W. Evans).

Easternness.—Nairn (J. E. Somerville). Kincaig by Kingussie (W. Evans).

Main Argyle.—Dunoon (W.D.R.).

Glyde Isles.—Loch Greenan, abundant (W.D.R.).

Cantire.—Tarbert; West Loch Tarbert (T. Scott).

Sutherland E.—Loch Brora; Golspie Burn; rock near the Mound; Little Ferry, Dornoch (W. Baillie).

Sutherland W.—Mouth of Halladaile River (W. Baillie).

Caithness.—Dunbeath River (W. Baillie).

***Testacella haliotides* Drap.**

This is an addition to Dr White's Scottish list, and has only been found in one Scottish locality.

Kirkcudbright.—Maxwelltown (R. Service).

***Testacella scutulum* Sow.**

This also—a distinct species from the last—is an addition to Dr White's Scottish list, and has only been found in nursery gardens in one Scottish locality.

Fife and Kinross.—Kirkcaldy (W. D. Sang).

***Succinea putris* (L.).**

There is a great gap in our knowledge of the Scottish range of this species, for, with the exception of a single record from Elgin and another from Caithness, we have no authentication for counties farther north than Renfrewshire on the west and Kincardineshire on the east side of the kingdom.

Kirkcudbright—Twynholm, on Tarff side; Hermitage Bank at Tongland; Tarff (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Ayr.—Largs (Alex. Shaw).

Lanark.—Possil Marsh (F. G. Binnie).

Renfrew.—The Cloch by Greenock (T. Scott).

Peebles.—Near Peebles (A. Somerville).

Selkirk.—Banks of Ettrick, above Tushielaw (W. Evans).

Roxburgh.—Hilliesland Moss near Hawick (W. G. Guthrie).

Haddington.—Gosford Ponds; Luffness Links, "inner corner" and "farthest marsh"; Dirleton Common near North Berwick (W. Evans).

Edinburgh.—Stream behind Lothianburn; var. *subglobosa*, near Edinburgh, 1888 (W. Evans).

Fife and Kinross.—Cliffs of St Andrews Bay (E. E. Prince). Kinkell Braes near St Andrews (W. Evans). Var. *subglobosa*, Lindores Loch (T. Scott).

Perth North.—Near Perth (H. Coates).

Forfar.—Mains of Usan near Montrose; Loch Rescobie (W. Duncan).

Kincardine.—Stonehaven (W. Turner).

Elgin.—Near Elgin (G. Gordon).

Clyde Isles.—Port Bannatyne (A. Shaw). Loch Fad (T. Scott).

Caithness.—Near Wick (T. Scott).

***Succinea elegans* Risso.**

Although one of its varieties has been recorded (by Dr Jeffreys) for Shetland, this species has not been authenticated by our referees for localities farther north than North Perthshire and Clyde Isles.

Kirkcudbright.—Tarff, Free Kirk reach (F. R. Coles).

Haddington.—Var. *ochracea*, common at both ends of Luffness Links (J. M'Murtrie). Pond, Luffness Links (W. Evans).

Edinburgh.—Var. *pfeifferi*, Canal bank near Slateford (J. W. Young, per W. Evans).

Fife and Kinross.—Burntisland (W. Evans).

Perth N.—Loch of Clunie, between Blairgowrie and Dunkeld (W. Evans).

Clyde Isles.—Var. *pfeifferi*, Arran (British Museum).

***Succinea oblonga* Drap.**

For this extremely rare British species we know of two Scottish stations only, one of them the historic Bathgate.

Ayr.—Quarry near Dalry (J. Steel, per T. Scott).

Linlithgow.—Bathgate (Alder Collection, Newcastle Museum).

***Vitrina pellucida* Müll.**

This is one of the species which range commonly throughout the kingdom, and should be expected to occur in every county. Records are still required for six counties, viz., Aberdeen N., Westernness, Cantire, Ebudes S., Ebudes N., and Shetland.

Dumfries.—Dumfries; Moffat (W. Evans).

Kirkcudbright.—Castle Douglas (W. Evans).

Wigtown.—Springbank near Stranraer (W. Evans).

Ayr.—Skelmorlie (W.D.R.). Largs (A. Shaw).

Renfrew.—Greenock (T. Scott).

Lanark.—Falls of Clyde near Lanark (B. Hudson). Blantyre (Alex. Shaw).

Peebles.—Walkerburn (W.D.R.). Soonhope; Rosetta near Peebles; Cademuir (W. Evans).

Selkirk.—Holylee and Thornielee (W.D.R.). Haining Woods near Selkirk (W. Evans).

Roxburgh.—Eildon Hills (W.D.R.).

Berwick.—Fans near Earlston (R. Renton). Earlston and Kirklands (W.D.R.). Pease Dean; Cockburnspath (W. Evans).

Haddington.—Drummorie (W.D.R.). Aberlady; Athelstaneford; Ballincrieff; Longniddry; Dunbar; North Berwick; Gullane Point; Gosford Woods (W. Evans).

Edinburgh.—Blackford Hill and Bonaly (W.D.R.). Arthur's Seat (R. F. Scharff). Craiglockhart Hill; Salisbury Crags; Duddingston House; Braid Hills; Pentlands near Hillend; Braidburn; Roslin Castle; Dalmahoy; Redford and Harmony near Balerno; Kirknewton; near Dalhousie; above Dreghorn; Lothianburn; Penicuik (W. Evans).

Linlithgow.—Philpstoun; Linlithgow (W. Evans).

Fife and Kinross.—Aberdour (B. Hudson). North Queensferry (W.D.R.). Crail; St Andrews; Dura Den; Strathtyrum; Kinkell Braes; Raith; Otterston; Aberdour; Earlsball near Leuchars (W. Evans).

Stirling.—Polmont (W. Evans).

Perth South with Clackmannan.—Callander (A. Somerville).

Perth Mid.—Loch Tay side (J. E. Somerville).

Perth N.—Near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Den of Airlie (C. B. Plowright). Craigs and Links, Montrose (W. Duncan). Douglas-field near Dundee (J. Ramage). Outskirts of Dundee (W. Evans).

Kincardine.—Stonehaven (W. Turner).

Aberdeen S.—Couler railway bank, Deeside (C. B. Plowright). Braemar (W. Evans).

Banff.—Tomintoul (L. Hinxman). Macduff (A. Robertson).

Elgin.—Near Elgin (G. Gordon).

Easterness.—Nairn (J. E. Somerville). Glen Feshie (W. Evans).

Main Argyre.—Oban (A. Somerville). Glen Morag; Dunoon (W.D.R.). Crinan, and along Kerrera Sound, Oban (J. E. Somerville).

Dumbarton.—High Mains and Crosslet near Dumbarton (W.D.R.). Garscadden and Duntocher (Alex. Shaw). Cardross (Hilderic Friend).

Clyde Isles.—Ardbeg, Bute (W.D.R.). Loch Fad, Bute (T. Scott). Port Bannatyne and Ettrick Bay, Bute; Loch Ranza, Arran (Alex. Shaw).

Ebudes Mid.—Tiree Island; Iona (J. E. Somerville).

Ross West.—Loch Carron; Gairloch; Balmacarra; Loch Broom (J. E. Somerville).

Ross East.—Between Bonar Bridge and Edderton (W. Baillie). Invergordon; Tain; Glenurquhart; Kincardine; Resolis (J. E. Somerville).

Sutherland E.—Loch Brora, abundant (W. Baillie). Helmsdale (J. E. Somerville).

Sutherland W.—Mouth of Halladaile river (W. Baillie). Stoer; Strathy; Farr; Durness; Erribol (J. E. Somerville).

Caithness.—Lybster; Thurso (J. E. Somerville). Near Wick (T. Scott).

Hebrides.—Callernish, Isle of Lewis; Loch Boisdale, in South Uist (J. E. Somerville).

Orkney.—Birsay (A. Isbister, per W. Evans).

Zonites draparnaldi Beck.

This species is a southern one, and it is possible that the Kincardineshire and Bute specimens are unusually fine and large examples of the next species. Otherwise the species constitutes an addition to Dr White's list.

Fife and Kinross.—St Andrews (W. Evans).

Kincardine.—Stonehaven, one (W. Turner).

Clyde Isles.—Rothsay, probably this species (Alex. Shaw).

Zonites cellarius (Müll.).

A generally distributed and common species, records of which for seven Scottish counties, viz., Aberdeen N., Westernness, Ebudes S., Ebudes N., Sutherland W., Orkney, and Shetland, are still wanting.

Dumfries.—Dumfries; Moffat (W. Evans).

Kirkcudbright.—Kirkcudbright (Wm. Thomson). Tongland Hill; Tarfside, etc. (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Wigtown.—Port Logan; Springbank near Stranraer (W. Evans).

Ayr.—Fairlie Glen (M. E. and G. W. Mellors). Skelmorlie (W.D.R.). West Kilbride (A. Somerville). Largs (A. Shaw). Maybole (W. Evans).

Renfrew.—Shielhill Glen; Greenock (T. Scott). Carmunnock (Alex. Shaw).

Lanark.—Glasgow (W. Nelson). Blantyre (A. Shaw).

Peebles.—Walkerburn (W.D.R.). Neidpath Castle; Cademuir; Dawick (W. Evans).

Selkirk.—Var. *albinos*, several at Thornelee (W.D.R.).

Roxburgh.—Eildon Hills (W.D.R.). Near Hawick (W. G. Guthrie).

Berwick.—Fans near Earlston (R. Renton). Redpath; Dryburgh Abbey (W.D.R.). Cockburnspath (W. Evans).

Haddington.—Drummore; Falside (W.D.R.). Aberlady; Dunbar; North Berwick; Gullane Point (W. Evans).

Edinburgh.—Edinburgh; Arthur's Seat (R. F. Scharff). Gardens in Edinburgh (J. M. Murtrie). Braid Hills; Hillend; Salisbury Crags; Roslin Castle; Dalmahoy; near Dalhousie; Craiglockhart Hill; Redford near Balerno; Kirknewton near Midcalder; above Dreghorn; Lothianburn; Duddingston House; Penicuik; var. *alba* near Fairmilehead (W. Evans).

Linlithgow.—South Queensferry (W.D.R.).

Fife and Kinross.—Cupar (T. Scott). Aberdour (B. Hudson). Cliffs near St Andrews (E. E. Prince). Pettycur Links; Dairsie; Kinkell Braes near

St Andrews; Strachtyra near St Andrews; Dura Den; Crail; Burntisland (W. Evans).

Stirling.—Pitlochry (W. Evans).

Perth S. with Clackmannan.—Callander; Pass of Leny (W. Evans).

Perth Mid.—Loch Tay side (J. E. Somerville). Birnam (W. Evans).

Perth N.—Near Perth (H. Coates). Blairgowrie (W. Evans).

Perth.—Ballin Cliffs near Montrose; Ussie (W. Duncan). Broughty Ferry (Alex. Somerville). Douglas-field near Dundee (J. Ramage). Outskirts of Dundee (W. Evans).

Kincaid.—Stonehaven (W. Turner).

Aberdeen S.—Aberdeen, Prof. Macgillivray (British Museum). Braemar (W. Evans).

Banff.—Macduff (A. Robertson).

Elgin.—Near Elgin (G. Gordon).

Eastern Ross.—Glen Feshie (W. Evans).

Main Argyll.—Loch Awe; Dunstaffnage Castle, Oban (A. Somerville). Glen Morag near Dunoon; Hunter's Quay (W.D.R.). Lismore (J. E. Somerville).

Dumbarton.—Crosslet near Dumbarton (W.D.R.). Garacadden; Forth and Clyde Canal at Maryhill (Alex. Shaw). Dunglass (J. E. Somerville). Var. *albinos*, Forth and Clyde Canal at Maryhill (A. Shaw).

Clyde Inlet.—Barone, Bute (W.D.R.). Rothesay Castle (M. E. and G. W. Mellors). Rothesay (J. Whitwham). Loch Fad; Rothesay (T. Scott). Port Bannatyne, with var. *albinos* (Alex. Shaw).

Cantire.—Tarbert (T. Scott). Machrehanish Bay; Island Davaar; Kilkerran Bay; var. *albinos*, Machrehanish Bay (A. Shaw).

Ebudes Mid.—Iona and Tiree (J. E. Somerville).

Ross W.—Ullapool (A. Somerville). Gairloch; Loch Carron (J. E. Somerville).

Ross E.—Tain (J. E. Somerville).

Sutherland E.—The Mound near Brora (W. Baillie).

Caithness.—Dunbeath Castle (W. Baillie).

Hebrides.—Eye near Stornoway; Lewis; Isle of Barra (A. Somerville). Callernish in Lewis; Loch Boisdale, S. Uist (J. E. Somerville).

Zonites alliarius (Müll.).

Another generally distributed and commonly occurring species, for which records are required for six counties, to wit, Stirling, Kincardine, Aberdeen N., Westerness, Ebudes S., and Ebudes N.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Castle Douglas (W. Evans).

Wigtown.—Springbank near Stranraer (W. Evans).

Ayr.—Fairlie Glen (M. E. and G. W. Mellors). Skelmorlie (W.D.R.; Alex. Shaw). West Kilbride (A. Somerville).

Renfrew.—Shielhill Glen (W.D.R.).

Lanark.—Blantyre (Alex. Shaw).

Peebles.—Walkerburn; Leadburn; Riddenless (W.D.R.). Slipperfield Loch near West Linton; Rosetta near Peebles (W. Evans).

Selkirk.—Elibank; Holylee (W.D.R.). Haining Woods near Selkirk (W. Evans).

Roxburgh.—Eildon Hills (W.D.R.).

Berwick.—Earlston; Kirklands; Dryburgh (W.D.R.). Cockburnspath; Pease Dean (W. Evans).

Haddington.—Drummole (W.D.R.). North Berwick; var. *viridula*, Bass Rock, where it is commoner than the type (J. M'Murtrie). Aberlady; Longniddry; Dunbar; Dirleton Common near North Berwick; Gullane Point (W. Evans).

Edinburgh.—Salisbury Crags (W.D.R.). Pentlands near Hillend; Braid Hills; Dregghorn; Blackford Hill; Harmony near Balerno, with var. *viridula*; near Dalhousie, with var. *viridula*; Roslin Castle; Dalmahoy, with var. *viridula*; Kirknewton, with var. *viridula* (W. Evans).

Linlithgow.—Linlithgow; Dalmeny Park (W. Evans).

Fife and Kinross.—Queensferry, Fife (R. F. Scharff). North Queensferry (W.D.R.). Isle of May; St Andrews; Aberdour; Earlsball near Leuchars (W. Evans).

Perth S. with Clackmannan.—Strathyre near Callander (W. Evans).

Perth Mid.—Near Kenmore (T. Scott). Loch Tay side; Kenmore; on an island in Loch Dochart (J. E. Somerville).

Perth North.—Near Perth (H. Coates). Persie Inn, Glenshee (W. Evans).

Forfar.—Montrose (W. Duncan). Den of Airlie (C. B. Plowright).

Aberdeen S.—The Links, Old Aberdeen (C. B. Plowright). Braemar (W. Evans).

Banff.—Tomintoul (L. Hinxman).

Elgin.—Near Elgin (G. Gordon).

Easterness.—Nairn; Strathglass; Glenurquhart (J. E. Somerville). Glen Feshie; Kincaig by Kingussie (W. Evans).

Main Argyle.—Wood alongside Kerrera Sound, Oban; also var. *viridula* (J. E. Somerville).

Dumbarton.—Crosslet near Dumbarton (W.D.R.).

Clyde Isles.—Ardbeg and Barone, Bute (W.D.R.). Rothesay Castle ruins (M. E. and G. W. Mellors). Rothesay; Loch Fad; var. *viridula*, Loch Fad (T. Scott). Ettrick Bay, Bute (A. Shaw).

Cantire.—Tarbert (T. Scott). Machrehanish Bay; near Campbeltown (Alex. Shaw).

Islands Mid.—Tiree Island (J. E. Somerville). Iona (A. Somerville).

Ross W.—Gairloch; Loch Broom; Balmacarra (J. E. Somerville).

Ross E.—Between Bonar Bridge and Edderton (W. Baillie). Resolis; Invergordon (J. E. Somerville).

Sutherland E.—Brora (W. Baillie). Rosehall; Strathoyke (J. E. Somerville).

Sutherland W.—Stoer; Durness; Erribol; Strathy; Farr (J. E. Somerville).

Caithness.—Dunbeath Castle (W. Baillie). Thurso; Lybster (J. E. Somerville).

Hebrides.—Callernish, Isle of Lewis; Loch Boisdale, South Uist (J. E. Somerville).

Orkney.—Birsay, with var. *viridula* (W. Evans).

Shetland.—Shetland (A. Merle Norman).

Zonites glaber (Stud.).

This has so far been reported from three western counties only, and is additional to Dr White's list.

Ayr.—Largs (Alex. Shaw).

Dumbarton.—By Forth and Clyde Canal at Maryhill (Alex. Shaw).

Clyde Isles.—Port Bannatyne, Bute (Alex. Shaw).

Zonites nitidulus (Drap.).

A generally distributed and common species, of which records for ten comital areas (Selkirk, Aberdeen N., Easternness, Westernness, Ebudes Mid, Sutherland E. and W., Hebrides, Orkney, and Shetland) are still deficient.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Castle Douglas (W. Evans). Tongland Hill; Skirney; Dee at Tongland; Skesney on Tarff side (F. R. Coles).

Wigtown.—Springbank near Stranraer (W. Evans).

Ayr.—Skelmorlie (W.D.R.; Alex. Shaw).

Renfrew.—Greenock; The Cloch (T. Scott). Shielhill Glen (W.D.R.). Houston near Paisley (H. Nelson). Carmunnock (Alex. Shaw).

Lanark.—Blantyre and Summerston (Alex. Shaw). Var. *nitens*, Falls of Clyde near Lanark (B. Hudson).

Peebles.—Soonhope; Neidpath Castle; Cademuir; Dawick (W. Evans).

Roxburgh.—Near Hawick; Wellogate, Hawick (W. G. Guthrie).

Berwick.—Earlston (W.D.R.). Cockburnspath (W. Evans).

Haddington.—Drummore; Falside (W.D.R.). Var. *nitens*, Dunbar (J. M'Murtrie). Aberlady; Dunbar; Gullane Point; Gosford Woods; Luffness Links; between Longniddry and Ballincrieff (W. Evans).

Edinburgh.—Arthur's Seat (R. F. Scharff). Blackford Hill and Levenhall (W.D.R.). Braid Hills; Braidburn; Salisbury Crags; Pentlands near Hillend; Fairmilehead; Kaim; Roslin Castle; Dalmahoy; near Balerno; Kirknewton; near Dalhousie; Castle Rock, Edinburgh; Davidson's Mains; Craiglockhart Hill; Lochend (W. Evans).

Linlithgow.—South Queensferry (W.D.R.). Linlithgow; Philipstoun (W. Evans).

Fife and Kinross.—North Queensferry (R. F. Scharff). Dura Den; Strath-tyrum; St Andrews; Crail; Aberdour (W. Evans).

Stirling.—Near Barlowie Loch (Alex. Shaw). Polmont (W. Evans).

Perth & with Clackmannan.—Callander (Alex. Somerville).

Perth Mid.—Loch Tay side; Kenmore (J. E. Somerville).

Perth North.—Near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Douglasfield near Dundee (J. Ramagel). Craigs (W. Duncan). Broughty Ferry (A. Somerville). Den of Airlie (C. B. Plowright). Outskirts of Dundee (W. Evans).

Kincardine.—Stonehaven, with var. *nitens* (W. Turner).

Aberdeen S.—Var. *nitens*, The Links, Old Aberdeen (C. B. Plowright).

Banff.—Tomintoul (L. Hinxman).

Elgin.—Near Elgin (G. Gordon).

Main Argyle.—Dunstaffnage Castle, Oban (A. Somerville). Hunter's Quay; Glen Morag; Dunoon; Ardenadam (W.D.R.).

Dumbarton.—Crosslet near Dumbarton (W.D.R.). Dunglass (J. E. Somerville). Duntocher; near Shandon, Gareloch; Garscadden; by Forth and Clyde Canal at Maryhill (Alex. Shaw).

Clyde Isles.—Barone, Bute (W.D.R.). Rothesay Castle ruins (G. W. and M. E. Mellors). Loch Fad; var. *nitens*, near Rothesay Aquarium (T. Scott).

Cantire.—Tarbert (T. Scott).

Ebudes S. or N.—A specimen or specimens in coll. A. Merle Norman, are labelled "Oronsay, Isle of Skye;" it or they are of the var. *nitens*.

Ross W.—Ullapool (A. Somerville).

Ross E.—Between Bonar Bridge and Edderton (W. Baillie). Dingwall (J. E. Somerville).

Caithness.—Dunbeath Castle (W. Baillie).

Zonites purus (Ald.).

A species of apparently general distribution and not uncommon occurrence in Scotland, which may be looked for as a possible component in every county list. The variety appears to be more prevalent than the type.

Dumfries.—Moffat, with var. *margaritacea* (W. Evans).

Kirkcudbright.—Var. *margaritacea*, Tongland (F. R. Coles).

Ayr.—Var. *margaritacea*, Largs (M. E. and G. W. Mellors). Skelmorlie (Alex. Shaw).

Renfrew.—Var. *margaritacea*, near Cloch (F. G. Binnie).

Roxburgh.—Eildon Hills (W.D.R.).

Berwick.—Var. *margaritacea*, Earlstoun (W.D.R.). Var. *margaritacea*, Pease Dean (W. Evans).

Haddington.—Var. *margaritacea*, Binning Woods (J. M'Murtrie). Redhouse near Longniddry; Gosford Woods (W. Evans).

Edinburgh.—Blackford Hill; var. *margaritacea*, Braid Hills; var. *margaritacea*, Braid Hermitage; near Dalhousie, with var. *margaritacea*; Kirknewton; Dalmahoy; Roslin Castle; Redford near Balerno; between Bavelaw and Loganlee; Lothianburn, with var. *margaritacea* (W. Evans).

Fife and Kinross.—Var. *margaritacea*, Aberdour (B. Hudson). Var. *margaritacea*, Dura Den; Kinkell Braes near St Andrews, with var. *margaritacea*; Earlsall near Leuchars; Otterston (W. Evans).

Perth S. with Clackmannan.—Callander (A. Somerville). Var. *margaritacea*, Pass of Leny, Callander (W. Evans).

Perth Mid.—Var. *margaritacea*, Birnam (W. Evans).

Perth N.—Var. *margaritacea*, near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Buddon; Montrose (W. Duncan). Den of Airlie, with var. *margaritacea* (C. B. Plowright).

Kincardine.—Var. *margaritacea*, Stonehaven (W. Turner).

Elgin.—Var. *margaritacea*, near Elgin (G. Gordon).

Easternness.—Glenurquhart; var. *margaritacea*, Strathglass (J. E. Somerville).

Westernness.—Var. *margaritacea*, sea-coast at Arisaig (J. E. Somerville).

Main Argyle.—Along Kerrera Sound, Oban (J. E. Somerville). Var. *margaritacea*, at Oban (British Museum); Glen Shira, Inveraray (F. G. Binnie).

Dumbarton.—Near Shandon, Gareloch (Alex. Shaw).

Clyde Isles.—Loch Fad (T. Scott). Var. *margaritacea*, near Rothesay, and in Skeoch Woods, Bute; Loch Ranza, Arran (Alex. Shaw).

Cantire.—East Loch Tarbert; var. *margaritacea*, Tarbert (T. Scott).

Ross W.—Var. *margaritacea*, sea-coast, Gairloch (A. Somerville).

Sutherland E.—Golspie Burn; Brora; var. *margaritacea*, Brora (W. Baillie).

Caithness.—Var. *margaritacea*, Dunbeath Castle (W. Baillie).

Zonites radiatulus (Ald.).

This species appears to range from south to north of the kingdom.

Dumfries.—Moffat (W. Evans).

Renfrew.—Greenock (T. Scott). Shielhill Glen (W.D.R.).

Lanark.—Kenmuir Bank (F. G. Binnie).

Edinburgh.—Edinburgh (British Museum). Salisbury Crags (W.D.R.). Dalmahoy; Fairmilehead; Lothianburn; Blackford Hill; Braid Hermitage; Braid Hills; Loganlee, Pentlands; Gorebridge (W. Evans).

Linlithgow.—Dalmeny Park (W. Evans).

Fife and Kinross.—Tentsmuir (W. Evans).

Perth S. with Clackmannan.—Callander (A. Somerville). Pass of Leny near Callander; var. *viridescens-alba*, Strathyre near Callander (W. Evans).

Perth North.—Near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Broughty Ferry (A. Somerville).

Aberdeen S.—The Links, Old Aberdeen (C. B. Plowright).

Elgin.—Near Elgin (G. Gordon).

Easternness.—Kincraig by Kingussie (W. Evans).

Main Argyle.—Oban (Janet Carphin).

Clyde Isles.—Loch Fad (T. Scott). Rothesay (Alex. Shaw).

Cantire.—Tarbert, also var. *viridescens-alba* (T. Scott).

Caithness.—Dunbeath Castle (W. Baillie).

Zonites nitidus (Müll.).

A species affecting moist situations, reported as yet from but three counties.

Perth North.—Butterston Loch near Dunkeld (W. Evans).

Easternness.—Kincraig by Kingussie (W. Evans).

Clyde Isles.—Shores of Loch Fad (T. Scott).

Zonites excavatus (Bean).

This species is restricted in its range, and has so far been authenticated from five counties only. Dr White mentions several other counties; from these our referees would be pleased to see examples.

Wigtown.—Knockglass near Stranraer (W. Evans).

Renfrew.—Abundant in Shielhill Glen; The Cloch near Greenock (T. Scott).

Perth S. with Clackmannan.—Strathyre near Callander (W. Evans).

Stirling.—Cumbernauld Glen (F. G. Binnie).

Clyde Isles.—Isle of Cumbrae (A. Merle Norman). Skeoch Woods near Rothesay (A. Shaw).

Zonites crystallinus (Müll.).

This small and not uncommon species appears to range throughout Scotland, and may be confidently looked for in all its comital areas.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Tongland; Twynholm; banks of Tarff (F. R. Coles). Castle Douglas (W. Evans).

Wigtown.—Springbank near Stranraer (W. Evans).

Ayr.—Skelmorlie (W.D.R.). Largs (A. Shaw).

Renfrew.—Shielhill Glen; The Cloch (T. Scott).

Lanark.—Small form, Blantyre (Alex. Shaw). Falls of Clyde near Lanark, small form (B. Hudson).

Peebles.—Peebles (A. Somerville). Standalane Braes near Peebles; Cademuir; Dawick (W. Evans).

Selkirk.—Small form, Thornielee (W.D.R.). Haining Woods near Selkirk, with var. *contracta* (W. Evans).

Roxburgh.—Wellogate, Hawick (W. G. Guthrie).

Berwick.—Earlston; Redpath; Kirklands; var. *subterranea*, Earlston, Cowdenknowes, Dryburgh Abbey (W.D.R.). Pease Dean; Cockburnspath (W. Evans).

Haddington.—Binning Woods; var. *contracta*, Binning Woods (J. M. Murtrie). Dunbar; Aberlady; North Berwick; Redhouse near Longniddry (W. Evans).

Edinburgh.—Edinburgh (British Museum). Pentlands near Hillend; var. *contracta*, Roslin Castle; var. *contracta*, Balerno; Gorebridge; between Bavelaw and Loganlee; var. *contracta*, Craiglockhart Hill Wood; Kirknewton, with var. *contracta*; Braid Hermitage, with var. *contracta*; Dalmahoy, with var. *contracta*; Lothianburn, with var. *contracta*; near Penicuik (W. Evans).

Linlithgow.—Var. *contracta*, near Linlithgow; Philpstoun; Dalmeny Park (W. Evans).

Fife and Kinross.—Var. *subterranea*, Aberdour (B. Hudson). Var. *contracta*, Cambo near Crail; Kinkell Braes near St Andrews; Dura Den; Otterston (W. Evans).

- Stirling.**—Polmont (W. Evans).
Perth S. with Clackmannan.—Callander (A. Somerville). Var. *contracta*,
 Pass of Leny, Callander (W. Evans).
Perth Mid.—Kenmore (A. Somerville).
Perth N.—Blairgowrie (W. Evans).
Forfar.—Montrose (W. Duncan). Den of Airlie (C. B. Plowright).
Kincardine.—Stonehaven (W. Turner).
Banff.—Tomintoul, with var. *contracta* (L. Hinxman).
Elgin.—Near Elgin (G. Gordon).
Easternness.—Strathglass (J. E. Somerville). Var. *contracta*, Glen Feshie
 (W. Evans).
Main Argyre.—Oban (British Museum). Along Kerrera Sound, Oban (J.
 E. Somerville).
Dumbarton.—High Mains near Dumbarton (W.D.R.). Garscadden;
 by Forth and Clyde Canal at Maryhill; the small form at Duntocher, and
 near Shandon, Gareloch (Alex. Shaw).
Clyde Isles.—Loch Fad (T. Scott). Skeoch Woods, Rothesay (A. Shaw).
Cantire.—Tarbert (T. Scott).
Ross W.—Sea-coast, Loch Broom (J. E. Somerville).
Sutherland E.—Golspie Burn and Brora (W. Baillie).
Caithness.—Dunbeath Castle (W. Baillie).

Zonites fulvus (Müll.).

Although still unauthenticated for fifteen counties, it is probable that this species will yet be found to range throughout the kingdom, and to occur in every area.

- Kirkcubright.**—Castle Douglas (W. Evans).
Wigtown.—Springbank near Stranraer (W. Evans).
Ayr.—Largs; Skelmorlie; Dalry Road, Largs (Alex. Shaw).
Renfrew.—Greenock (T. Scott). Cloch; Shielhill Glen (W.D.R.).
Leamark.—Glasgow (Alex. Shaw).
Perth.—Cadenyatt; Dawick; Sornhope (W. Evans).
Seikirk.—Hunting Woods near Seikirk (W. Evans).
Berrwick.—Phase Dean (W. Evans).
Haddington.—Luffness (J. M. Martrie). Gosford Woods; Luffness Links
 (W. Evans).
Edinburgh.—Edinburgh (British Museum). Kirknewton near Midcalder;
 Muirton Hill near H. Ford; Blackhorn Hill; Braids Hermitage; Gorebridge;
 Dudding; Rosyth Castle (W. Evans).
Leith.—Leith (W. Evans).
Fife and Dundee.—Dunnottar; Kirkcubright near St Andrews (W. Evans).
Perth S. with Clackmannan.—Pass of Leny, Callander (W. Evans).
Perth Mid.—Kenmore (A. Somerville). Strath W. Evans.
Perth North.—Near Elgin (G. Gordon). Loch of Clunie, between Blair-
 gowrie and Elgin (W. Evans).
Forfar.—Montrose (W. Duncan). Den of Airlie (C. B. Plowright).

Kincaidina.—Stonehaven, scarce (W. Turner).
Elgin.—Near Elgin (G. Gordon).
Main Argyll.—Oban (British Museum).
Dumbarton.—Garscadden (Alex. Shaw).
Clyde Isles.—Barone, Bute (W.D.R.). Loch Fad (T. Scott).
Cantire.—Tarbert (T. Scott).
Ross W.—Sea-coast, Loch Broom and Gairloch (J. E. Somerville).
Sutherland E.—Brora (W. Baillie).
Sutherland W.—Durness and Erribol (J. E. Somerville).
Caithness.—Dunbeath Castle (W. Baillie).

***Helix lamellata* Jeff.**

Of wide range, and probably not uncommon in many Scottish localities, though as yet it has only been authenticated for eight counties.

Kirkcubright.—New Abbey (J. M. Murrie).
Ayr.—Skelmorlie (Alex. Shaw).
Stirling.—Craigquarter Wood, Howietoun near Stirling (T. Scott).
Perth M.—Birnans (H. Coates).
Main Argyll.—Inveraray (B. Sturges Dodd).
Clyde Isles.—Skeoch Woods, Bute (Alex. Shaw).
Ross E.—Between Bonar Bridge and Edderton (W. Baillie).
Sutherland E.—Golspie Burn (W. Baillie). Brora (A. Somerville).

***Helix sculeata* Mull.**

Also a wide-ranging species, which will be found in scattered localities throughout the kingdom by painstaking collectors.

Kirkcubright.—Near Castle Douglas (W. Evans).
Ayr.—Maybole common (H. Storer). Skelmorlie (Alex. Shaw).
Renfrew.—Greenock (A. Somerville).
Selfkirk.—Hanning Woods near Selfkirk (W. Evans).
Berwick.—Peebles Dean (W. Evans).
Haddington.—Liffness (J. M. Murrie). Gosford Woods (W. Evans).
Edinburgh.—Braid, Hermitage; Dalmaib; Gorseburgh; Craiglockhart Hill wood (W. Evans).
Fife and Kinross.—Dura Den (W. Evans).
Perth M.—Near Perth (H. Coates). Requires confirmation as to country.
Forfar.—Mortrose (W. Druce).
Elgin.—Cortis on the Fiddich (G. Gordon).
Main Argyll.—Oban (British Museum). Along Kintyre Sound (J. E. Somerville). Oban (J. E. Somerville).
Sutherland E.—Golspie Burn and Brora (W. Baillie).
Caithness.—Found high up the Dunbeath River (W. Baillie).

***Helix aspersa* Müll.**

A species apparently of nearly universal range in Scotland by the coast, and occurring in many inland localities also. Apparently wanting in the extreme northern counties.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Close to Kirkcudbright (W. Thomson).

Wigtown.—Stranraer; Port Logan (W. Evans).

Ayr.—Skelmorlie (W.D.R.). Maybole; outskirts of Ayr (W. Evans). Largs (A. Shaw).

Renfrew.—Common about Greenock; m. *scalariforme*, Crawford Street, Greenock (T. Scott).

Peebles.—Neidpath Castle (W. Evans).

Roxburgh.—Kelso (W. G. Guthrie).

Berwick.—Cockburnspath; Coldingham; Berwick-on-Tweed (W. Evans).

Haddington.—North Berwick; Bass Rock (J. M'Murtrie). Haddington (W. Turner). Drummorie (W.D.R.) *Var. undulata, zonata, flammea, aff. nigrescens* and *aff. obscurata* at North Berwick (J. M'Murtrie).

Edinburgh.—Braidburn (W. E. Clarke). Levenhall; Bonaly (W.D.R.). Craigleith; Granton (W. Evans).

Linlithgow.—Dalmeny Park; Linlithgow (W. Evans).

Fife and Kinross.—North Queensferry (W.D.R.). *Aff. undulata*, St Andrews; Raith; *aff. zonata*, Crail (W. Evans).

Perth North.—Kinnoul Hill near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Montrose (W. Duncan). Arbroath (A. Somerville).

Banff.—Banff (W. Baillie).

Elgin.—Near Elgin (G. Gordon).

Westernness.—Ardtornish Castle, Sound of Mull (B. Hndson).

Main Argyre.—Dunoon and Hunter's Quay (W.D.R.).

Dumbarton.—High Mains near Dumbarton (W.D.R.).

Clyde Isles.—Rothesay Castle ruins (M. E. and G. W. Mellors). Ardbeg and Rothesay (W.D.R.). *Var. undulata*, Rothesay Castle; *var. aff. globosa*, St Blane's Chapel; Loch Ranza, Arran (A. Shaw). *Var. depressa*, near Rothesay (T. Scott).

Cantire.—Old Castle of Tarbert, etc. (T. Scott). Island Davaar; Kilkerran Bay; Machrehanish Bay; *var. undulata*, Machrehanish Bay (Alex. Shaw). *Var. zonata*, Tarbert (T. Scott).

Ebudes S.—Port Charlotte, Islay (W. Evans).

Ebudes Mid.—Iona Cathedral walls (T. Scott). Common at Iona (A. Somerville).

Hebrides.—Isle of Barra, plentiful (A. Somerville; J. E. Somerville).

***Helix nemoralis* L.**

This species is apparently absent from the more northern counties, where its place is occupied by the next species.

South of Argyleshire and Easternness it is, however, probably universal in its range and of common occurrence.

Dumfries.—Vars. *castanea* and *libellula* at The Grey Mare's Tail; vars. *libellula* and *rubella* at Moffat (J. Madison; W. Evans). Var. *rubella*, Dumfries (W. Evans).

Kirkcudbright.—Dee at Tongland (F. R. Coles). Vars. *libellula* and *rubella*, Kirkcudbright (W. Thomson). Var. *rubella*, Castle Douglas (W. Evans).

Wigtown.—Springbank near Stranraer, vars. *libellula* and *rubella* (W. Evans).

Ayr.—Var. *libellula*, Skelmorlie (W.D.R.). Myremill Holm at Maybole; Crossraguel Abbey (H. Nelson). Fairlie Glen (M. E. and G. W. Mellors). Largs (Alex. Shaw). Var. *rubella*, Maybole; Myremill Holm near Maybole (H. Nelson). Largs (A. Shaw). Skelmorlie (W.D.R.). Ardrossan and Largs (A. Shaw).

Renfrew.—Var. *libellula*, Greenock; Dunroad Siding; var. *rubella*, Greenock (T. Scott).

Lanark.—Vars. *libellula* and *rubella*, Summerston (A. Shaw).

Peebles.—Vars. *libellula* and *rubella*, Walkerburn (W.D.R.). Vars. *libellula* and *rubella*, Neidpath Castle (W. Evans).

Selkirk.—Var. *libellula*, Thornielee and Holylee; Tweed side at Peel near Galashiels; var. *castanea*, Holylee (W.D.R.).

Roxburgh.—Vars. *libellula* and *rubella*, Melrose Abbey walls (W.D.R.). Both vars., Minto near Hawick (W. G. Guthrie).

Berwick.—Var. *libellula*, Fans near Earlstoun (R. Renton). Redpath (W.D.R.). Var. *rubella*, Fans (R. Renton). Dryburgh (W.D.R.). Vars. *carnea* and *libellula*, Cockburnspath (W. Evans).

Haddington.—Var. *rubella*, Falside (W.D.R.). North Berwick, vars. *libellula* and *castanea* (J. M'Murtrie). Aberlady, several vars. (W. Evans).

Edinburgh.—Var. *libellula*, Braid Burn (W. E. Clarke). Near Craigleith Station; Blackford Hill; Bonaly; Torduff Reservoir (W.D.R.). Var. *rubella*, Braid Burn (W. E. Clarke). Near Craigleith Station; Bonnyfield; Bonaly; Craiglockhart (W.D.R.). Var. *carnea*, Braidburn (W. Evans).

Linlithgow.—Var. *libellula*, Dalmeny Park (W.D.R.). Linlithgow (W. Evans).

Fife and Kinross.—North Queensferry; St Andrews (R. F. Scharff). Var. *libellula*, Links at Elie; Cupar Fife; var. *rubella*, Links at Elie; Cupar (T. Scott). Var. *castanea*, North Queensferry (W.D.R.). Links at Elie (T. Scott). Var. *libellula*, Crail; numerous varieties, including *roseolabiata*, St Andrews (W. Evans).

Stirling.—Var. *libellula*, near Bardowie Loch; Balmore; var. *rubella*, Balmore, Summerston, and near Bardowie Loch (Alex. Shaw). Var. *libellula*, Polmont (W. Evans).

Perth Mid.—Var. *libellula*, Balgowan (F. B. White). Kenmore; Styx by Kenmore (T. Scott). Var. *rubella*, Balgowan (F. B. White). Styx by Kenmore (T. Scott).

Perth N.—Var. *rubella*, Dunkeld; vars. *rubella* and *libellula*, Blairgowrie (W. Evans).

Forfar.—Var. *libellula*, The Links, Montrose (W. Duncan). Gallie Burn, Dundee; near Trottick Kirk; Stannergate, Dundee; Douglasfield; Pitkerro Road, Dundee; and railway side between Dundee and Broughty Ferry (J. Ramage). Arbroath (A. Somerville). Den of Airlie (C. B. Plowright). Var. *rubella*, Hill Street, Dundee; Gallie Burn, Dundee (J. Ramage). Dundee (W. Evans). The Links, Montrose; var. *castanea*, Montrose (W. Duncan).

Westernness.—Var. *rubella*, Foyers, Loch Ness (B. Hudson).

Main Argyle.—Var. *rubella*, Innellan (A. Somerville). Hunter's Quay (W.D.R.). Var. *libellula*, Lismore; Kerrera Island (A. Somerville). Hunter's Quay (W.D.R.).

Dumbarton.—Var. *libellula*, Duntocher; Forth and Clyde Canal at Maryhill; near Garscadden (A. Shaw). Var. *rubella*, High Mains near Dumbarton (W.D.R.). Duntocher; near Shandon, Gareloch; Forth and Clyde Canal near Garscadden, and at Maryhill (Alex. Shaw). Cardross (H. Friend).

Clyde Isles.—Aquarium at Rothesay; Loch Fad (T. Scott). Var. *rubella*, Port Bannatyne (A. Shaw). Var. *libellula*, Barone, Bute (W.D.R.). Loch Fad and Rothesay; Ardbeg, Bute (A. Shaw).

Cantire.—Var. *libellula*, Tarbert (T. Scott). Campeltown; Island Davaar (Alex. Shaw). Var. *rubella*, Tarbert (T. Scott). Campbeltown (A. Shaw). Var. *castanea*, Tarbert (T. Scott).

Ebudes S.—Var. *libellula*, Islay (R. Scott Skirving).

Ebudes Mid.—Iona (A. Somerville). Var. *libellula*, Island of Coll (T. Scott).

Hebrides.—Var. *libellula*, churchyard of Eye near Stornoway (A. Somerville).

***Helix hortensis* Müll.**

Of wider range than *H. nemoralis*, and is to be found in all probability in every comital area.

Kirkcudbright.—Var. *lutea*, Kirkcudbright (W. Thomson; F. R. Coles). Var. *lutea*, Castle Douglas, and near Maxwelltown (W. Evans).

Ayr.—Var. *lutea*, Dalry (T. Scott). Laigh Culzean near Maybole (H. Nelson). Largs; Ardrossan (A. Shaw).

Renfrew.—Var. *lutea*, Scott's Glen near Greenock (T. Scott).

Lanark.—Var. *incarnata*, near Glasgow (R. Standen). Var. *lutea*, Falls of Clyde (B. Hudson). Stonehouse (T. Scott). Summerston and Blantyre (Alex. Shaw).

Roxburgh.—Var. *lutea*, Hassenden near Hawick (W. G. Guthrie).

Berwick.—Fans near Earliston (R. Renton). Var. *lutea*, below Pease Dean (W. Evans).

Haddington.—Var. *lutea*, North Berwick (J. M'Murtrie). Dunbar (B. Hudson).

Edinburgh.—Var. *roseolabiata*, Cramond Island (T. Scott). Roslin Castle, var. *lutea* (W. Evans).

Fife and Kinross.—Var. *lutea*, Aberdour (B. Hudson). Cliffs of St Andrews Bay (E. E. Prince). Dura Den; Kinkell near St Andrews (W. Evans).

Stirling.—Var. *lutea*, Summerston (Alex. Shaw).

- Perth Mid.**—Var. *lutea*, Balgowan (H. Coates).
Perth N.—Var. *lutea*, Glen Tilt (F. Buchanan White). Var. *lutea*, Blairgowrie (W. Evans).
Forfar.—Var. *olivacea*, Arbroath (A. Somerville). Var. *lutea*, Links at Montrose (W. Duncan). Den of Airlie (C. B. Plowright). Arbroath (A. Somerville).
Kincardine.—Stonehaven, dwarf (W. Turner). Var. *lutea*, Banchory (W. Evans).
Aberdeen S.—Var. *lutea*, Couler railway bank, Deeside (C. B. Plowright). Var. *lutea*, Braemar (W. Evans).
Banff.—Tomintoul (L. Hinxman). Craighalkie (G. Gordon).
Elgin.—Near Elgin (G. Gordon).
Easternness.—Var. *lutea*, Glenurquhart (J. E. Somerville).
Westernness.—Var. *lutea*, Ardtornish Castle, Sound of Mull (B. Hudson).
Dumbarton.—Var. *lutea*, between Luss and Tarbert (Marcus Calder).
Dunglass (J. E. Somerville).
Ebudes Mid.—Var. *lutea*, Iona (T. Rogers; A. Somerville). Tobermory, Mull (W. Evans).
Ross East.—Var. *lutea*, Tain (J. E. Somerville).
Sutherland E.—Var. *olivacea*, Mound near Brora; var. *lutea*, Rock south of the Mound; Mound; Loch Brora; Gull Island, in Loch Brora; Lothbeg (W. Baillie).
Sutherland W.—Var. *olivacea*, Tongue (W. Baillie). Var. *lutea*, Strathy (J. E. Somerville). Tongue; mouth of Halladaile River (W. Baillie).
Caithness.—Var. *lutea*, Latheronwheel (W. Baillie).
Hebrides.—Var. *lutea*, Barra Island (A. Somerville).

***Helix arbustorum* L.**

Though somewhat local, is apparently a species which is to be found throughout Scotland, and may be expected to occur in every county.

- Dumfries.**—Grey Mare's Tail (J. Madison). Var. aff. *rudis*, and var. *fusca*, Bell Crug Wood, Moffat (Miss F. M. Hele).
Ayr.—Largs (A. Shaw).
Renfrew.—Greenock, common; var. *cincla*, Greenock; var. *alpestris*, Shielhill Glen (T. Scott).
Lanark.—Glasgow (H. Nelson). Near Summerston, with vars. *cincla*, *alpestris*, and *poiretia* (Alex. Shaw).
Roxburgh.—Howden Burn near Hawick (W. G. Guthrie).
Haddington.—At foot of Traprain Law; North Berwick, plentiful, with vars. *major*, *alpestris*, *flavescens*, and *cincla* (J. M'Murtrie). Canty Bay (W. Evans).
Edinburgh.—Var. *alpestris*, banks of Water of Leith, about four miles above Balerno (W. Evans).
Linlithgow.—Queensferry (Greville Collection, Edinburgh Museum). Hope-toun Woods, with var. *alpestris* (W. Evans).

Berwick.—Dryburgh Abbey; Dryburgh; Kirklands (W.D.R.). Cockburnspath (W. Evans).

Haddington.—Drummore (W.D.R.). Dunbar; var. *minor*, North Berwick (J. M'Murtrie). Longniddry; Aberlady; Ballincrieff; North Berwick; Dunbar (W. Evans).

Edinburgh.—Levenhall; Wallyford; Bonaly; Salisbury Crags (W.D.R.). Braid; Fairmilehead and Kaimies with var. *subrufa*; Roslin Castle; near Dalhousie; Edinburgh Castle Rock with var. *alba*; Craiglockhart Hill; Braidburn; Blackford Hill (W. Evans).

Linlithgow.—Linlithgow, close to town (W. Evans).

Fife and Kinross.—St Andrews; Dura Den; Kinkell Braes; Strathtyrum; Dairsie; Crail; Aberdour (W. Evans).

Stirling.—Near Bardowie Loch (A. Shaw). Polmont (W. Evans).

Perth Mid.—Kenmore (T. Scott; J. E. Somerville).

Perth M.—Near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Buddon and Craigs, near Montrose (W. Duncan). Broughty Ferry (A. Somerville). Den of Airlie (C. B. Plowright). Douglasfield near Dundee, with var. *subrufa* (J. Ramage). Outskirts of Dundee (W. Evans).

Kincardine.—Stonehaven (W. Turner).

Main Argyle.—Dunoon; Ardenadam; Hunter's Quay (W.D.R.). Isle of Lismore (J. E. Somerville). Var. *albida*, Dunoon; var. *subrufa*, Glen Morag near Dunoon (W.D.R.).

Dumbarton.—Duntocher and Garscadden; var. *depilata*, Duntocher; var. *albida* and *subglobosa*, Garscadden (A. Shaw).

Clyde Isles.—Near Rothesay (T. Scott). Ardbeg, Bute (W.D.R.). Rothesay Castle ruins (M. E. and G. W. Mellors). Loch Fad; Port Bannatyne (A. Shaw).

Cantire.—Var. *fusca*, Campbeltown (Alex. Shaw).

***Helix sericea* Müll.**

The authenticated records of this species are, with one exception, limited to a belt of midland counties of Scotland, and it has not been submitted for the more northern and a large proportion of the lowland counties.

Ayr.—Skelmorlie (T. Scott). Largs (Alex. Shaw).

Renfrew.—Tower Hill at Gourrock (T. Scott).

Edinburgh.—Banks of the Gore, below Gorebridge (W. Evans).

Forfar.—Buddon, near Montrose (W. Duncan).

Kincardine.—Stonehaven (W. Turner).

Elgin.—Banks of the Findhorn (G. Gordon).

Main Argyle.—Kilchurn Castle, Loch Awe (A. Somerville).

Clyde Isles.—Port Bannatyne (Alex. Shaw).

Cantire.—West Loch Tarbert (T. Scott). Campbeltown (Alex. Shaw). Var. *cornea*, Old Castle of Tarbert (T. Scott).

Isbudes Mid.—Abundant near the Inn, Iona (A. Somerville).

***Helix fusca* Mont.**

This most interesting species will, when carefully searched for, probably be found to occur throughout Scotland, and may be expected from nearly every area.

- Dumfries.**—Moffat (W. Evans).
Kirkcudbright.—Tariff Braes and Tongland (F. R. Coles).
Ayr.—Skelmorlie (W.D.R. ; T. Scott ; A. Shaw). Largs (Alex. Shaw).
Renfrew.—The Cloch ; Shielhill Glen (T. Scott). Hills above Greenock (F. G. Binnie).
Lanark.—Falls of Clyde (J. E. Somerville).
Peebles.—Dawick (W. Evans).
Roxburgh.—Melrose (A. Merle Norman).
Edinburgh.—Edinburgh (British Museum). Habbie's Howe in Pentland Hills ; Gorebridge (W. Evans).
Perth Mid.—Heugh of Caul (J. Whitwham).
Forfar.—Den of Airlie (C. B. Plowright).
Aberdeen S.—Couler railway bank, Deeside (C. B. Plowright).
Main Argyre.—Glen Shira, Inveraray (F. G. Binnie). Oban (Janet Carphin).
Clyde Isles.—Port Bannatyne ; near Rothesay (Alex. Shaw). Loch Fad (T. Scott).
Cantire.—Kilkerran Bay (Alex. Shaw).
Ross E.—Between Bonar Bridge and Edderton (W. Baillie).
Sutherland E.—Bonar (W. Baillie).

***Helix virgata* DaCosta.**

This species is limited to one single locality in Scotland. It is additional to Dr White's list.

- Ayr.**—Troon, with var. *alba* (A. Somerville). Troon, with vars. *alba*, *albicans*, *subdeleta*, and *maritima* (Janet Carphin).

***Helix caperata* Mont.**

A species which apparently ranges throughout Scotland, and especially the maritime counties, for most of which it ought eventually to be placed on record.

- Wigtown.**—Port Logan (W. Evans).
Ayr.—Maybole (H. Nelson). Largs (Alex. Shaw). Skelmorlie (T. Scott).
West Kilbride (A. Somerville). Ayr, with var. *fulva* ; Maybole (W. Evans).
Ardrossan (A. Shaw).
Lanark.—East Kilbride (T. Scott).
Berwick.—Berwick-on-Tweed ; Cockburnspath (W. Evans).

Haddington.—North Berwick; also var. *major* (J. M'Murtrie). Dirleton Common near North Berwick; Aberlady; near Longniddry; Gullane Point (W. Evans).

Edinburgh.—Salisbury Crags (British Museum). Blackford Hill (W.D.R.; W. Evans). Var. *ornata*, Levenhall and Blackford Hill (W.D.R.).

Linlithgow.—Queensferry (Greville Collection, Edinburgh Museum). Dalmeny Park (W. Evans).

Fife and Kinross.—North Queensferry (R. F. Scharff). Crail (W. Evans).

Stirling.—Polmont (W. Evans).

Forfar.—Hedderwick Quarry (W. Duncan). Broughty Ferry (A. Somerville).

Aberdeen S.—Aberdeen (J. MacGillivray in Brit. Mus.). The Links, Old Aberdeen (C. B. Plowright).

Elgin.—Elginshire, with vars. *ornata* and *major* (G. Gordon).

Dumbarton.—Dumbarton (Alex. Shaw). Cardross (Hilderic Friend).

Clyde Isles.—Ettrick Bay, Bute (A. Shaw).

Cantire.—Machrehanish Bay and Campeltown; var. *ornata*, Campeltown (A. Shaw).

Sutherland E.—Rock near the Mound; Little Ferry Links, about 9 miles S. of Brora (W. Baillie).

Sutherland W.—Mouth of Halladaile River (W. Baillie).

***Helix ericetorum* Müll.**

To judge by the authenticated records here given, this species would appear to have a strong predilection for the western counties.

Fife and Kinross.—Links at Elie, with vars. *alba* and *minor* (T. Scott). Largo (W. Evans).

Westernness.—Ardtornish Castle, Sound of Mull (B. Hudson).

Clyde Isles.—St Ninian's Bay, Bute (T. Scott).

Cantire.—Machrehanish Bay, with vars. *monozona* and *obliterata* (Alex. Shaw).

Ebudes Mid.—Mull; Tiree (J. E. Somerville). Iona (A. Somerville). Coll (T. Scott). Var. *minor*, Iona; var. *leucozona*, Iona (A. Somerville). Tiree (J. E. Somerville). Var. *monozona*, Iona (A. Somerville). Var. *alba*, Coll (T. Scott). Var. *instabilis*, Tiree (J. E. Somerville).

Sutherland W.—Mouth of Halladaile River; east of Kyle of Tongue, with vars. *obscura*, *alba*, *leucozona*, and *minor*; vars. *alba* and *leucozona* also near mouth of Halladaile River (W. Baillie). Sutherlandshire (Alder Collection at Newcastle). W. Baillie speaks of a colony at Brora, East Sutherland, probably introduced by himself.

Caithness.—Near Castlehill, Olrig (C. W. Peach, per G. Gordon).

Hebrides.—Isle of Harris (Alder Collection at Newcastle Museum). Barra and South Uist (J. E. Somerville). Churchyard of Eye near Stornoway (A. Somerville). Var. *leucozona*, Isle of Harris (J. Stark in Alder Collection). Var. *instabilis*, Barra (J. E. Somerville).

***Helix rotundata* Müll.**

A species of apparently universal range and abundant occurrence, of which records for seven counties (Aberdeen N., Banff, Easternness, Ebudes S., Hebrides, Orkney, and Shetland) are still needed.

Dumfries.—Dumfries; Moffat (W. Evans).

Kirkcudbright.—High Boreland; Tongland Hill; Dee at Tongland; Tarff Bank, Twynholm (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Wigtown.—Springbank near Stranraer; Port Logan (W. Evans).

Ayr.—Skelmorlie (W.D.R.). Fairlie Glen; Largs (M. E. and G. W. Mellors). West Kilbride (A. Somerville). Largs (A. Shaw).

Renfrew.—Common about Greenock (T. Scott). Inverkip; Shielhill Glen (W.D.R.). Houston near Paisley (H. Nelson). Carmunnock (Alex. Shaw). Var. *alba*, The Cloch; var. *pyramidalis*, Shielhill Glen (T. Scott).

Lanark.—Falls of Clyde near Lanark (B. Hudson). Summerston; Blantyre (A. Shaw).

Peebles.—Walkerburn (W.D.R.). West Linton; Neidpath Castle; Dawick (W. Evans).

Selkirk.—Thornielee; Elibank; Holylee (W.D.R.). Haining Woods near Selkirk (W. Evans).

Roxburgh.—Hawick (W. G. Guthrie).

Berwick.—Earlston; Kirklands; Redpath; Dryburgh; var. *alba*, Dryburgh Abbey (W.D.R.). Pease Dean; Cockburnspath (W. Evans).

Haddington.—Drummore and Falside (W.D.R.). Dunbar; var. *alba*, Bass Rock; var. *turtoni*, North Berwick (J. M'Murtrie). Dunbar; North Berwick; Aberlady; near Longniddry (W. Evans).

Edinburgh.—Arthur's Seat, with var. *alba* (R. F. Scharff). Salisbury Crags; Levenhall; Wallyford; Bonaly; Blackford Hill (W.D.R.). Cramond Island (T. Scott). Craiglockhart Hill (W. Evans). Roslin Castle; Pentlands near Hillend; Duddingston; Dalmahoy; Kirknewton near Midcalder; Balerno; near Dalhousie; Castle Rock, Edinburgh; Braid; Davidson's Mains (W. Evans).

Linlithgow.—Dalmeny; South Queensferry (W.D.R.). Linlithgow, close to town; Dalmeny Park; Philpstoun (W. Evans).

Fife and Kinross.—North Queensferry; St Andrews (R. F. Scharff). Cliffs of St Andrews Bay (E. E. Prince). Aberdour (B. Hudson). Crail; Strathtyrum near St Andrews; Dura Den; Dairsie; Raith; Aberdour (W. Evans).

Stirling.—Balmore; near Bardowie Loch (Alex. Shaw). Polmont (W. Evans).

Perth S. with Clackmannan.—Callander (A. Somerville). Pass of Leny near Callander (W. Evans).

Perth Mid.—Balgowan (H. Coates). Kenmore (T. Scott). Loch Tay side (J. E. Somerville). Island in Loch Dochart (A. Somerville).

Perth N.—Near Perth (H. Coates). Dunkeld; Blairgowrie (W. Evans).

Forfar.—Usan Woods near Montrose (W. Duncan). Broughty Ferry (A. Somerville). Douglasfield near Dundee (J. Ramage). Den of Airie (C. B. Plowright). Outskirts of Dundee (W. Evans).

Kincardine.—Stonehaven (W. Turner).

Aberdeen S.—Aberdeen, Prof. MacGillivray (British Museum).

Elgin.—Near Elgin (G. Gordon).

Westernness.—Ardtornish Castle, Sound of Mull (B. Hudson). Arisaig (J. E. Somerville).

Main Argyle.—Oban and Loch Awe (A. Somerville). Dunoon; Glen Morag; Ardenadam; Hunter's Quay (W.D.R.). Wood along Kerner Sound (J. E. Somerville).

Dumbarton.—Castle Rock, Crosslet, and High Mains near Dumbarton (W.D.R.). Dunglass (J. E. Somerville). Cardross (Hilderic Friend). Duntocher; Shandon, Gareloch; by Forth and Clyde at Canal Maryhill, and near Garscadden (A. Shaw). Var. *alba*, Crosslet (W.D.R.).

Clyde Isles.—Ardbeg and Barone, Bute (W.D.R.). Rothesay (J. Whitwham). Rothesay Castle (M. E. and G. W. Mellors). Loch Fad (T. Scott). Port Bannatyne (Alex. Shaw). Var. *minor*, near Rothesay (T. Scott).

Cantire.—Tarbert (T. Scott). Machrehanish Bay; Kilkerran Bay (Alex. Shaw). Var. *alba*, Tarbert (T. Scott). Var. *turtoni*, Machrehanish Bay (A. Shaw).

Ebudes Mid.—Iona (A. Somerville).

Ebudes N.—Eigg (A. Somerville).

Ross W.—Loch Broom; Loch Carron; Glenelg (J. E. Somerville).

Ross E.—Between Bonar Bridge and Edderton (W. Baillie). Kincardine; Glenurquhart (J. E. Somerville).

Sutherland E.—Golspie Burn and Brora (W. Baillie). Creich (J. E. Somerville).

Sutherland W.—Strathy; Farr; Durness; Erribol (J. E. Somerville).

Caithness.—Very common in Caithness (W. Baillie).

***Helix rupestris* Drap.**

Apparently restricted to two localities on the eastern side of Scotland.

Edinburgh.—Wall at Duddingston Loch (W. Evans).

Perth N.—Near Perth (H. Coates).

***Helix pygmaea* Drap.**

This minute species is probably reported from the few counties we cite, more by reason of its being difficult to find than really scarce. It is reported from widely-separated areas, and to the farthest northern verge of the mainland of Scotland.

Kirkcubright.—Near Castle Douglas (W. Evans).

Ayr.—Skelwarrie (A. Shaw).

- Peebles.**—Soonhope ; Standalane near Peebles ; Dawick (W. Evans).
Berwick.—Pease Dean (W. Evans).
Haddington.—Luffness (J. M'Murtrie). Gosford Woods (W. Evans).
Edinburgh.—Blackford Hill ; Bush near Penicuik (W. Evans).
Fife.—Kinkell Braes near St Andrews ; Earlsall near Leuchars (W. Evans).
Stirling.—Polmont (W. Evans).
Perth S. with Clackmannan.—Near Pass of Leny, Callander (W. Evans).
Perth N.—Near Perth (H. Coates). Blairgowrie (W. Evans).
Aberdeen N.—Loch Strathbeg near Fraserburgh (T. Scott).
Dumbarton.—Near Luss, Loch Lomond (F. G. Binnie).
Clyde Isles.—Ardmalish Point near Port Bannatyne (T. Scott). Loch Ranza, Arran (A. Shaw).
Sutherland E.—Golspie Burn (W. Baillie).
Sutherland W.—Tongue Wood (W. Baillie).
Ross W.—Ullapool (A. Somerville).
Caithness.—Dunbeath (W. Baillie).

***Helix pulchella* Müll.**

This pretty little species is widely distributed in Scotland, and in all probability will eventually be found to inhabit every comital area. Its range so far seems to be restricted to the eastern coast counties, and three of those on the west. Records are deficient for all inland and western lowland counties.

- Berwick.**—Var. *costata*, Dryburgh Abbey ruins (W.D.R.).
Haddington.—Luffness (J. M'Murtrie). Gosford ; Dirleton Common ; Aberlady, with var. *costata* ; Longniddry ; North Berwick ; Gullane Point (W. Evans).
Edinburgh.—Salisbury Crags ; Blackford Hill (W.D.R.). Braid Hills ; Lothianburn (W. Evans).
Linlithgow.—Queensferry (Greville Collection in Edinburgh Museum). Requires confirmation as to county.
Fife and Kinross.—North Queensferry (R. F. Scharff). Crail (W. Evans).
Perth N.—Near Perth (H. Coates ; F. Buchanan White). Blairgowrie (W. Evans).
Forfar.—Broughty Ferry (A. Somerville).
Kincardine.—St Cyrus, with var. *costata* (W. Duncan).
Elgin.—Burghead (G. Gordon).
Easternness.—Nairn (J. E. Somerville).
Clyde Isles.—Ardmalish Point near Port Bannatyne (T. Scott). Ettrick Bay (A. Shaw).
Cantire.—Machrehanish Bay (Alex. Shaw).
Ebudes N.—Eigg (A. Somerville).
Sutherland E.—Brora, plentiful (W. Baillie).

Helix lapicida L.

Restricted to one single locality in Scotland, and now extinct there.

Boxburgh.—Formerly at Weensland Road, Hawick—locality now destroyed by the extension of building operations (W. G. Guthrie).

Bulimus acutus (Müll.).

A strictly littoral species, confined to the western or Atlantic sea-board, but ranging there from extreme north to south.

Wigtown.—Galloway, W. Bean (Greville Collection, Edinburgh Museum).

Ayr.—Troon (F. G. Binnie). With var. *strigata*, Troon (Janet Carphin).

Cantire.—Machrehanish Bay, with vars. *inflata* and *strigata* (Alex. Shaw).

Ebudes Mid.—Iona (A. Somerville). Mull and Tiree (J. E. Somerville). Coll (T. Scott). Vars. *alba* and *strigata*, Iona (H. H. Slater). Var. *bizona*, Tiree (J. E. Somerville). Iona (W. Evans).

Ebudes N.—Eigg (A. Somerville).

Sutherland W.—North coast of Sutherlandshire (J. Backhouse). Durness (Edinburgh Museum).

Caithness.—Near Duncansby Head (G. Gordon). Near Castlehill, Olrig (C. W. Peach, per G. Gordon).

Hebrides.—Churchyard of Eye near Stornoway (A. Somerville). Benbecula Island; South Uist (J. E. Somerville). Var. *articulata*, Barra Island (A. Somerville).

Bulimus obscurus (Müll.).

All the counties from which this species has been authenticated are situated (with the single exception of Lanarkshire) on the eastern side of the kingdom, from Elginshire southwards.

Lanark.—Falls of Clyde near Lanark (B. Hudson).

Berwick.—Dryburgh (W. D. R.). Cockburnspath (W. Evans).

Haddington.—North Berwick (J. M'Murtrie). Gosford Woods; Canty Bay near North Berwick (W. Evans).

Edinburgh.—Salisbury Crags (British Museum). Edinburgh (R. F. Scharff). Arthur's Seat close to Duddingston; between Fairmilehead and Kaimes; Craiglockhart Hill (W. Evans).

Linlithgow.—Queensferry (Greville Collection, Edinburgh Museum). Requires confirmation as to county.

Perth Mid.—Kenmore (J. E. Somerville).

Perth N.—Near Perth (H. Coates).

Forfar.—Buddon Cliffs near Montrose (W. Duncan).

Kincardine.—Stonehaven (W. Turner).

Banff.—Tomintoul (L. Hinxman).

Elgin.—Cothill on the Findhorn (G. Gordon).

***Pupa ringens* Jeff.**

A local species, authenticated from nine counties only, but of possible occurrence in several others.

Ayr.—Skelmorlie (A. Shaw).

Renfrew.—Shielhill Glen near Greenock, with var. *pallida* (T. Scott).
Near the Cloch, with var. *pallida* (F. G. Binnie).

Fife.—Kinkell Braes near St Andrews (W. Evans).

Kincardine.—Stonehaven (W. Turner).

Main Argyle.—Oban (Janet Carphin).

Cantire.—Var. *pallida*, north shore of East Loch Tarbert (T. Scott).

Ross E.—Between Bonar Bridge and Edderton (W. Baillie).

Sutherland E.—Bonar (W. Baillie).

Sutherland W.—East of Kyle of Tongue (W. Baillie).

***Pupa umbilicata* Drap.**

A species of apparently universal distribution in Scotland, which will in all probability be added eventually to every comital list.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Near Kirkcudbright (F. R. Coles). Castle Douglas (W. Evans).

Wigtown.—Port Logan (W. Evans).

Ayr.—Maybole (H. Nelson). West Kilbride (A. Somerville). Skelmorlie (W.D.R.). Largs (A. Shaw).

Renfrew.—Shielhill Glen, with var. *albina* (T. Scott). Var. *edentula*, Houston near Paisley (H. Nelson). Hills above Greenock (F. G. Binnie).

Peebles.—Rosetta near Peebles (W. Evans).

Roxburgh.—Darnlee near Melrose (W.D.R.). Kyles Moss near Hawick (W. G. Guthrie).

Berwick.—Earlston and Cowdenknowes (W.D.R.). Pease Dean; Cockburnspath (W. Evans).

Haddington.—Drummore (W.D.R.). Luffness; North Berwick, with var. *edentula* (J. M'Murtrie). Aberlady; Dunbar; Gullane Point; Gosford Woods; Redhouse near Longniddry; Dirleton Common (W. Evans).

Edinburgh.—Arthur's Seat (R. F. Scharff). Salisbury Crags; Blackford Hill; Bonaly (W.D.R.). Craiglockhart Hill; var. *curta*, Salisbury Crags; Roslin Castle; Balerno; Dalmahoy; near Dalhousie; Castle Rock, Edinburgh; above Dreghorn; Davidson's Mains; Lothianburn; Pentland Hills near Hillend, with var. *edentula*; Braid Hills (W. Evans).

Linlithgow.—Near Linlithgow (W. Evans).

Fife and Kinross.—North Queensferry (R. F. Scharff). Near Cupar (T. Scott). Dura Den; Kinkell Braes; Crail; Aberdour; Earlsbarr near Leuchars (W. Evans).

Stirling.—Polnoon (W. Evans).

Perth & with Clackmannan.—Strathyre and Pass of Leny, both near Ca.ander (W. Evans).

Perth E.—Near Perth (H. Coates).

Perth.—The Links, Montrose (W. Duncan).

Kincardine.—Stonehaven (W. Turner).

Banff.—Tomintoul (L. Hixman).

Elgin.—Near Elgin (G. Gordon).

Westerness.—Lismore (A. Somerville).

Main Argyll.—Oban; Innishail Island on Loch Awe (A. Somerville). Wood along Kerrera Sound at Oban (J. E. Somerville). Dunoon (W.D.R.). Inveraray and Glen Shira (F. G. Binnie).

Dumbarton.—Tarbet by Loch Lomond (M. E. and G. W. Mellors). Near Shandon, Gareloch (A. Shaw).

Clyde Isles.—Ardbeg, Bute (W.D.R.). Rothesay Castle ruins (M. E. and G. W. Mellors). Loch Fad; near Rothesay (T. Scott). St Blane's Chapel, Bute; Port Bannatyne; Ettrick Bay, Bute (Alex. Shaw).

Cantire.—Campbeltown; Machrehanish Bay (Alex. Shaw).

Hebrides Mid.—Tiree Island (J. E. Somerville). Var. *edentula*, Iona (A. Somerville).

Ross W.—Ullapool (A. Somerville). Glenelg; Loch Carron (J. E. Somerville).

Ross E.—Between Bonar Bridge and Edderton (W. Baillie).

Sutherland E.—Brora, rock south of the Mound, etc. (W. Baillie). Helmsdale (J. E. Somerville).

Sutherland W.—Durness; Erribol; Stoer; Strathy, with var. *edentula*; Farr, with var. *edentula* (J. E. Somerville). Var. *edentula*, east of Kyle of Tongue (W. Baillie).

Caithness.—Thurso (J. E. Somerville).

Hebrides.—Castlebay, Barra Island; Eye Churchyard near Stornoway (A. Somerville). Benbecula Island; Loch Boisdale, South Uist (J. E. Somerville).

Pupa marginata Drap.

The few stations hitherto reported for this species are situate in the immediate vicinity of the coast.

Haddington.—Aberlady; Dirleton Common near North Berwick (W. Evans). North Berwick, with var. *edentula* (J. M'Murtrie).

Edinburgh.—Arthur's Seat (Hilderic Friend). Var. *edentula*, Braid Hills; Gorebridge (W. Evans).

Fife.—Crail; St Andrews (W. Evans).

Kincardine.—Var. *edentula*, Stonehaven (W. Turner).

Elgin.—Near the sea, Elginshire (G. Gordon).

Clyde Isles.—Var. *albina*, Millport (T. Scott).

Sutherland W.—Mouth of Halladaile River (W. Baillie).

***Vertigo antivertigo* (Drap.).**

Close search in suitable (*i.e.*, moist) situations will doubtless reveal the presence of this minute species in numerous localities. Those already on record range from north to south, and from east to west.

Berwick.—Berwickshire (Alder Collection at Newcastle Museum).

Haddington.—Luffness (J. M'Murtrie). Luffness Marshes (W. Evans).

Elgin.—Lesmurdie Cottage near Elgin (G. Gordon).

Clyde Isles.—Loch Ascog and Loch Fad (T. Scott).

Ross E.—Between Bonar Bridge and Edderton (W. Baillie).

Sutherland E.—Golspie Burn (W. Baillie).

***Vertigo pygmæa* (Drap.).**

As with the last-named species, this one—the recorded localities for which range over the length and breadth of the kingdom—will most probably be found of universal distribution.

Ayr.—Skelmorlie (W.D.R.).

Renfrew.—Shielhill and Rottenburn Glens (T. Scott).

Peebles.—Standalane Braes near Peebles (W. Evans).

Selkirk.—Thornielee (W.D.R.).

Haddington.—North Berwick Law (J. M'Murtrie). Longniddry; Waterworks, North Berwick (W. Evans).

Edinburgh.—Arthur's Seat (R. F. Scharff). Salisbury Crags; Blackford Hill (W.D.R.). Near Duddingston Loch; Blackford Hill (W. Evans).

Kincardine.—Stonchaven (W. Turner).

Elgin.—Near Elgin (G. Gordon).

Clyde Isles.—Near Ardmalish Point, Kyles of Bute; Loch Fad (T. Scott).

Ross W.—Ullapool (A. Somerville).

Sutherland E.—Golspie Burn (W. Baillie).

Gaithness.—Dunbeath (W. Baillie).

***Vertigo substriata* (Jeff.).**

Authenticated for three counties only, though Dr White speaks of it in his list as a common and widely spread species. It would be of interest to verify this statement.

Clyde Isles.—Loch Fad, Bute (T. Scott).

Fife and Kinross.—Kinkell Braes near St Andrews (W. Evans)

Sutherland E.—Brora (W. Baillie).

***Vertigo pusilla* Müll.**

This is an addition to Dr Buchanan White's list, and has hitherto been authenticated from two counties only.

Edinburgh—Banks of the Cloven near Maxwelltown (R. Rimmer).

Ayr—Largo W. Turner; specimens in collection of A. Merle Norman.

***Vertigo angustior* Jeff.**

This scarce species—authenticated from one county only—
is an addition to Dr White's list.

Sutherland E.—Strathmore W. Baillie.

***Vertigo edentata* (Drap.).**

This species will probably be found to be of general distribution, its already-authenticated stations ranging from south to north and from east to west.

Ayr—Largo East Largo A. Shaw.

Banff—Loch near Greenock T. Scott.

Perth—Glasgow, Dawick W. Evans.

Burgh—Glasgow A. Merle Norman. Pease Dean (W. Evans).

Edinburgh—Lifford J. M. Macriest. Longniddry; Gosford Woods (W. Evans).

Edinburgh—Glasgow: Brail Hermitage; Craiglockhart Hill Wood (W. Evans).

Fife and Kinross—Kirkcaldy Brans near St Andrews; Dura Den (W. Evans).

Stirling—Near Kilmarnock F. G. Rennie.

Perth & with Chesham—Pass of Leny, Callander (W. Evans).

Perth—Near Perth H. Coates.

Forfar—Near Forfar W. Duncan.

Edinburgh—Glasgow W. Turner.

Highland—Wood near Kerrera Sound, Oban (J. E. Somerville).

Clyde—Glasgow A. Merle Norman. Loch Fad (T. Scott). Rothesay and Port Bannatyne A. Shaw.

Caithness—North shore of East Loch Tarbert (T. Scott).

Sutherland E.—Glasgow Bura, with var. *columella* (W. Baillie).

Sutherland W.—East of Kyle of Tongue; var. *columella*, Tongue (W. Baillie).

Caithness—Dunrobin or Latheronwheel (W. Baillie).

***Vertigo minutissima* (Hartm.).**

This minute and very local species has been as yet authenticated from two counties only. Dr Buchanan White speaks

of its having been found in the same place
which it is described in the same place

Redington - [redacted]
 in chief - [redacted]
 Edinburgh - [redacted]
 castle Museum - [redacted]
 (W. Evans.

This species is ~~very common~~
local—in the ~~San Joaquin~~
are still ~~very common~~

local - 30
are still waiting
Kirkpatrick - 30
Ayr - 30
Shaw - 30

Apr. - Economic
 Shaw.
 Schick - New School - Lecture
 Raleigh - Howard T. - Lecture
 Barwick - J. - Lecture
 Haddington - J. - Lecture
 Edinburgh - J. - Lecture
 Craiglockhart, H. - Lecture
 Park near Glasgow - Lecture
 and Glasgow - Lecture

Ark near Condon. — *Arctostaphylos* — *Arctostaphylos* —
 File and Kansas. — *Arctostaphylos* — *Arctostaphylos* —
 Stirling. — *Arctostaphylos* — *Arctostaphylos* —
 North Hill. — *Arctostaphylos* — *Arctostaphylos* —
 North H. — *Arctostaphylos* — *Arctostaphylos* —
 Kansas. — *Arctostaphylos* — *Arctostaphylos* —
 South. — *Arctostaphylos* — *Arctostaphylos* —
 Elgin. — *Arctostaphylos* — *Arctostaphylos* —
 Main Arctostaphylos. — *Arctostaphylos* — *Arctostaphylos* —
 Clyde Lake. — *Arctostaphylos* — *Arctostaphylos* —
 Canine. — *Arctostaphylos* — *Arctostaphylos* —
 Southland E. — *Arctostaphylos* — *Arctostaphylos* —
 Canine. — *Arctostaphylos* — *Arctostaphylos* —

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Vertigo pusilla Müll.

This is an addition to Dr Buchanan White's list, and has hitherto been authenticated from two counties only.

Kirkcudbright.—Banks of the Clouden near Maxwelltown (R. Rimmer).

Ayr.—Largs (W. Templer; specimens in collection of A. Merle Norman).

Vertigo angustior Jeff.

This scarce species—authenticated from one county only—is also additional to Dr White's list.

Sutherland E.—Strathbrora (W. Baillie).

Vertigo edentula (Drap.).

This species will probably be found to be of general distribution, its already-authenticated stations ranging from south to north, and from east to west.

Ayr.—Dalry Road, Largs (A. Shaw).

Renfrew.—Cloch near Greenock (T. Scott).

Peebles.—Cademuir; Dawick (W. Evans).

Berwick.—Cowdenknowes (A. Merle Norman). Pease Dean (W. Evans).

Haddington.—Luffness (J. M'Murtrie). Longniddry; Gosford Woods (W. Evans).

Edinburgh.—Gorebridge; Braid Hermitage; Craiglockhart Hill Wood (W. Evans).

Fife and Kinross.—Kinkell Braes near St Andrews; Dura Den (W. Evans).

Stirling.—Near Milngavie (F. G. Binnie).

Perth S. with Clackmannan.—Pass of Leny, Callander (W. Evans).

Perth N.—Near Perth (H. Coates).

Forfar.—Near Montrose (W. Duncan).

Kincardine.—Stonehaven (W. Turner).

Main Argyle.—Wood along Kerrera Sound, Oban (J. E. Somerville).

Clyde Isles.—Cumbræ (A. Merle Norman). Loch Fad (T. Scott). Rothesay and Port Bannatyne (A. Shaw).

Cantire.—North shore of East Loch Tarbert (T. Scott).

Sutherland E.—Golspie Burn, with var. *columella* (W. Baillie).

Sutherland W.—East of Kyle of Tongue; var. *columella*, Tongue (W. Baillie).

Caithness.—Dunbeath or Latheronwheel (W. Baillie).

Vertigo minutissima (Hartm.).

This minute and very local species has been as yet authenticated from two counties only. Dr Buchanan White speaks

of its having been found at Balmerino in Fifeshire, a locality which it is desirable should be re-investigated.

Haddington.—North Berwick Law, one; North Berwick beach, cast up in shell sand (J. M'Murtrie).

Edinburgh.—Arthur's Seat (Edward Forbes, in Alder Collection at Newcastle Museum). Salisbury Crags (J. M'Murtrie). Craiglockhart Hill (W. Evans).

***Balea perversa* (L.).**

This species is apparently of universal distribution—though local—in Scotland, although records for numerous counties are still wanting.

Kirkcudbright.—Tongland (F. R. Coles). Castle Douglas (W. Evans).

Ayr.—Skelmorlie (T. Scott; A. Shaw). Largs; Dalry Road, Largs (Alex. Shaw).

Selkirk.—Near Selkirk (J. Madison).

Roxburgh.—Hawick (W. G. Guthrie).

Berwick.—Cockburnspath (W. Evans).

Haddington.—Canty Bay near North Berwick; Gullane Point (W. Evans).

Edinburgh.—Arthur's Seat (W. Nicol, in Alder Collection at Newcastle). Craiglockhart Hill; Blackford Hill; Lothianburn; Salisbury Crags; Caroline Park near Granton; walls, Craighouse and Colinton Road (W. Evans).

Fife and Kinross.—Kirkcaldy (W. Evans).

Stirling.—Campsie Glen (F. G. Binnie).

Perth Mid.—Moncrieff Hill (F. G. Binnie).

Perth N.—Near Perth (F. Buchanan White; H. Coates).

Kincardine.—Stonehaven (W. Turner).

Banff.—Tomintoul (L. Hinxman).

Elgin.—Near Elgin (G. Gordon).

Main Argyle.—Kilmun (Andrew Scott). Inveraray (F. G. Binnie).

Clyde Isles.—Rothesay; Port Bannatyne (A. Shaw). Loch Fad (T. Scott).

Cantire.—Tarbert (T. Scott). Campbeltown (Alex. Shaw).

Sutherland E.—Golspie Wood (W. Baillie).

Caithness.—Dunbeath (W. Baillie).

***Olausilia rugosa* (Drap.).**

A species of apparently universal range in Scotland, which may be confidently looked for in every one of the comital areas, though as yet it remains unauthenticated for fourteen of them.

Kirkcudbright.—Close to Kirkcudbright (W. Thomson). Dee, Tongland (F. R. Coles).

Wigtown.—Port Logan (W. Evans).

Ayr.—Largs (M. E. and G. W. Mellors ; A. Shaw). Skelmorlie (W.D.R.).
Var. tumidula, Largs ; Skelmorlie (A. Shaw).

Renfrew.—Gourock (Thos. W. Bell). Greenock, common (T. Scott). *Monst. decollatum*, Inverkip Road and near Dunroed Siding at Greenock (T. Scott).

Lanark.—Near Glasgow (W. Nelson). Falls of Clyde near Lanark (B. Hudson).

Roxburgh.—Hawick (W. G. Guthrie).

Haddington.—Canty Bay near North Berwick (W. Evans).

Edinburgh.—Arthur's Seat (R. F. Scharff). Salisbury Craigs ; Roslin Castle (W. Evans).

Fife and Kinross.—Cliffs of St Andrews Bay (E. E. Prince). *Var. tumidula*, Newburgh (W. H. Heathcote). Aberdour Woods ; St Andrews ; Raith ; Dura Den, with *var. dubia* (W. Evans).

Stirling.—Stirling (Jenyns, in Greville Collection at Edinburgh Museum).

Perth S. with Clackmannan.—Callander (W. Evans).

Perth Mid.—Near Perth (H. Bendall). Kenmore (T. Scott). Island on Loch Dochart (A. Somerville). Head of River Tummel, with *var. gracilior* (J. R. Hardy).

Perth N.—Near Perth (H. Coates). Blairgowrie (W. Evans).

Forfar.—Buddon near Montrose (W. Duncan). Den of Airlie (C. B. Plowright).

Kincairdine.—Stonehaven (W. Turner).

Banff.—Tomintoul (L. Hinxman).

Elgin.—Near Elgin (G. Gordon).

Westerness.—Lismore (A. Somerville). Arisaig (J. E. Somerville).

Main Argyll.—Oban (R. D. Darbshire). Dunstaffnage near Oban ; Loch Awe (A. Somerville). Inveraray ; Wood along Kerrera Sound at Oban (J. E. Somerville). Dunoon ; Glen Morag (W.D.R.). *Var. tumidula*, Loch Awe (A. Somerville).

Dumbarton.—Near Dumbarton (Alex. Shaw). High Mains near Dumbarton, with *var. parvula* (W.D.R.).

Clyde Isles.—Rothesay (J. Whitwham). Rothesay Castle ruins (M. E. and G. W. Mellors). Port Bannatyne and St Blane's Chapel, Bute (Alex. Shaw). Kintyre Bay, Bute, with *var. tumidula* (T. Scott).

Cantire.—Tarbert (T. Scott). Campbeltown ; Island Davaar ; Machrehanish Bay ; *var. tumidula*, Campbeltown (Alex. Shaw).

Islands Mid.—Iona (H. H. Slater).

Ross W.—Ullapool (A. Somerville). Balmacarra ; Loch Carron (J. E. Somerville).

Sutherland E.—Dunrobin Woods ; Golspie Burn ; Mound ; Brora (W. Baillie).

Sutherland W.—Ruins of Castle on Loch Assynt (W. Baillie).

Caithness.—Dunbeath (W. Baillie). Dunnet Sands near Thurso (W. Evans).

***Clausilia laminata* (Mont.).**

Very rare and local. It is very singular that its solitary Scottish locality should be so far removed from the northern

limit of its English distribution. It is essentially a shell of the English type of distribution, ranging throughout England even to Cumberland and Northumberland, and practically absent from Scotland, Wales, the Cornish peninsula, and Ireland.

Perth N.—Near Perth (H. Coates).

***Azeca tridens* (Pult.).**

Of this very local species—which Dr Buchanan White records as having been found at Bridge of Allan and in Dumfriesshire—specimens have as yet been authenticated by our referees from the former locality only.

Perth S. with Clackmannan.—Var. *nouletiana*, near Bridge of Allan (Hunterian Museum, Glasgow, per John Young).

***Zua lubrica* (Müll.).**

A species of universal distribution in Scotland, records of which are still wanting for the following five counties:—Perth S., Aberdeen N., Ebudes S., Ebudes N., and Orkney.

Dumfries.—Moffat (W. Evans).

Kirkcudbright.—Tongland (F. R. Coles). Castle Douglas (W. Evans).

Wigtown.—Port Logan; Springbank near Stranraer (W. Evans).

Ayr.—Skelmorlie (W.D.R.). Largs (M. E. and G. W. Mellors). West Kilbride (A. Somerville). Var. *lubricoides*, Skelmorlie (W.D.R.). Largs (Alex. Shaw). Maybole (W. Evans). Largs; Skelmorlie (A. Shaw).

Renfrew.—Houston near Paisley (H. Nelson). Cloch; Greenock (T. Scott). Shielhill Glen (W.D.R.)

Lanark.—Possil Marsh (W.D.R.). Blantyre (Alex. Shaw).

Peebles.—Earlyburn (W.D.R.). West Linton; Neidpath Castle and several other localities close to Peebles (W. Evans).

Selkirk.—Thornielee (W.D.R.).

Roxburgh.—Peasehill (W.D.R.) Kyles Moss near Hawick, with var. *lubricoides* (W. G. Guthrie).

Berwick.—Kirklands; Redpath; Earlstoun; var. *lubricoides*, Kirklands (W.D.R.). Pease Dean; Berwick-on-Tweed; Cockburnspath (W. Evans).

Haddington.—Drummore, with var. *lubricoides* (W.D.R.). Luffness, with var. *lubricoides* (J. M'Murtrie). Aberlady, with var. *ovata*; Dunbar; North Berwick; Gosford Woods; Gullane Point; Redhouse near Longniddry; Dirleton Common near North Berwick (W. Evans).

Edinburgh.—Salisbury Crags; var. *ovata*, Blackford Hill (W.D.R.). Braid Hills; above Dreghorn; Davidson's Mains; Redford near Balerno, with var. *lubricoides*; near Dalhousie; Caroline Park near Granton (W. Evans).

Linlithgow.—Philpstoun (W. Evans).

Fife and Kinross.—North Queensferry (W.D.R.). St Andrews; Strath-tyrum; Kinkell Braes; Crail (W. Evans).

Stirling.—Balmore (Alex. Shaw). Polmont (W. Evans).

Perth Mid.—Kenmore (T. Scott). Island in Loch Dochart (A. Somerville). Var. *lubricoides*, Kenmore (J. E. Somerville).

Perth N.—Near Perth, with var. *lubricoides* (H. Coates). Dunkeld; Blairgowrie (W. Evans).

Forfar.—Broughty Ferry (A. Somerville). Douglasfield near Dundee (J. Ramage). Den of Airlie (C. B. Plowright). Usan Woods near Montrose, with var. *lubricoides* (W. Duncan).

Kincardine.—Stonehaven (W. Turner).

Aberdeen S.—Coulter Railway Bank, Deeside (C. B. Plowright). Braemar, with var. *lubricoides* (W. Evans).

Banff.—Tomintoul, with var. *lubricoides* (L. Hinxman).

Elgin.—Near Elgin (G. Gordon).

Easterness.—Glen Feshie; Kincaig by Kingussie (W. Evans).

Westerness.—Pictish tower at Glenelg (A. Somerville).

Main Argyre.—Oban (A. Somerville). Glen Morag near Dunoon (W.D.R.). Isle of Lismore (J. E. Somerville). Var. *viridula*, Dunoon (W.D.R.).

Dumbarton.—Garscadden; Duntocher; by Forth and Clyde Canal at Maryhill (A. Shaw).

Clyde Isles.—Rothesay (W. Nelson). Barone and Ardbeg, Bute (W.D.R.). Loch Fad (T. Scott). Port Bannatyne (Alex. Shaw). Rothesay Castle ruins, with var. *lubricoides* (M. E. and G. W. Mellors). Var. *lubricoides*, Loch Fad; Ettrick Bay, Bute (A. Shaw).

Cantire.—Machrehanish Bay; var. *ovata*, Kilkerran Bay (Alex. Shaw).

Eludes Mid.—Iona (A. Somerville). Tiree Island (J. E. Somerville). Var. *lubricoides*, Iona (A. Somerville).

Ross W.—Ullapool (A. Somerville). Gairloch; Loch Carron (J. E. Somerville).

Ross E.—Invergordon (J. E. Somerville).

Sutherland E.—The Mound; near Brora; var. *lubricoides*, Mound (W. Baillie).

Sutherland W.—East of Kyle of Tongue (W. Baillie). Durness; Erribol; Strathy; Farr (J. E. Somerville).

Caithness.—Brawl Castle (W. Baillie).

Hebrides.—Loch Boisdale, South Uist (J. E. Somerville).

Shetland.—Shetland (British Museum).

***Carychium carychium* (Mont.).**

This minute species will doubtless be found to occur in every area, its authenticated distribution ranging throughout the kingdom.

Kirkcudbright.—Colly Wall and Twynholm, bank of Tarff (F. R. Coles). Maxwelltown; Castle Douglas (W. Evans).

- Wigtown.**—Springbank near Stranraer (W. Evans).
Ayr.—Largs; Skelmorlie; Dalry Road, Largs (Alex. Shaw).
Renfrew.—Cloch; near Greenock (T. Scott).
Lanark.—Blantyre (Alex. Shaw).
Peebles.—Standalane Braes near Peebles; Dawick (W. Evans).
Selkirk.—Haining Woods near Selkirk (W. Evans).
Berwick.—Pease Dean (W. Evans).
Haddington.—Binning Wood (J. M'Murtrie). Quarry near Gullane; Luffness Links; Dunbar; Gosford Woods (W. Evans).
Edinburgh.—Gorebridge; between Bavelaw and Loganlee; Redford near Balerno; Kirknewton near Midcalder; Braid Hermitage; Fairmilehead; near Penicuik (W. Evans).
Linlithgow.—Dalmeny Park (W. Evans).
Fife and Kinross.—Kinkell Braes near St Andrews; Dura Den; Cambo near Crail; Raith; Otterston (W. Evans).
Perth S. with Clackmannan.—Pass of Leny near Callander (W. Evans).
Perth N.—Near Perth (H. Coates). Butterston Loch near Dunkeld; Blairgowrie (W. Evans).
Forfar.—Montrose (W. Duncan). Broughty Ferry (A. Somerville). Den of Airlie (C. B. Plowright).
Kincardine.—Stonehaven (W. Turner).
Elgin.—Near Elgin (G. Gordon).
Main Argyle.—Oban (British Museum).
Clyde Isles.—Loch Fad (T. Scott). Skeoch Woods, Bute (Alex. Shaw).
Cantire.—North shore of East Loch Tarbert (T. Scott).
Sutherland E.—Brora (W. Baillie).

***Acme lineata* (Drap.).**

This very rare and local species has been found in Lanarkshire, Main Argyle, and Ebudes N. according to Dr White, but hitherto specimens have been submitted for authentication from two counties only.

- Renfrew.**—The Cloch near Greenock, one found (Andrew Scott).
Ayr.—Skelmorlie (A. Shaw).

***Neritina fluviatilis* (L.).**

Although Dr Buchanan White's words seem to imply that this shell is Scottish, it cannot be regarded as such; both the authenticated records are for accidental importations with river ballast from England or abroad.

- Renfrew.**—Greenock, among ballast sand (T. Scott).
Orkneys.—Orkney Islands (E. Forbes, in British Museum).

Paludina vivipara L.

We have, through the kindness of Rev. Dr Gordon, seen the original specimen recorded in his Morayshire list from the mouth of the Findhorn. It is evidently a ballast-shell, being bleached, much worn, and broken.

Bythinia tentaculata (L.).

Rare and local in Scotland. In addition to the five counties from which specimens have been sent for authentication, Dr White mentions its having occurred at Fraserburgh, Aberdeenshire.

Kirkcudbright.—Carlingwark Loch, Castle Douglas (W. Evans).

Renfrew.—Paisley Canal (J. Conacher). Glasgow and Paisley Canal, with var. *producta* (T. Scott).

Lanark.—Coatbridge Canal, an operculum only (Hilderic Friend).

Edinburgh.—Canal between Edinburgh and Slateford, with m. *decollatum* (W. Evans).

Linlithgow.—Canal at Linlithgow (W. Evans).

Valvata piscinalis (Müll.).

This species is sparingly distributed over the south-eastern half of Scotland, within which area it should be looked for in other counties than those stated below.

Kirkcudbright.—Tarff, Free Kirk reach; Tongland (F. R. Coles). **Maxwelltown;** Castle Douglas (W. Evans).

Renfrew.—Glasgow and Paisley Canal (T. Scott).

Haddington.—Gosford Ponds (W. Evans).

Edinburgh.—Edinburgh (W. Turner). Lochend, R. S. Ed. 1859 (Greville Collection in Edinburgh Museum). Lochend; Duddingston Loch (W. Evans).

Fife and Kinross.—Lindores Loch (T. Scott). Raith Lake (W. Evans). Loch Leven; Kirkcaldy (T. Scott).

Stirling.—Loch Coulter (T. Scott).

Perth N.—Near Perth (H. Coates).

Forfar.—Dun's Ditch near Montrose (W. Duncan).

Valvata cristata Müll.

Recorded from eight counties only, but will probably be found to occur in others.

Kirkcudbright.—Dee; Black Stockton (F. R. Coles).
Lanark.—Possil Marsh (T. Scott).
Haddington.—Gosford Ponds (W. Evans).
Edinburgh.—Marsh near Davidson's Mains (W. Evans).
Fife and Kinross.—Otterston Loch (W. Evans).
Forfar.—Rescobie Loch (W. Duncan).
Ross E.—Loch Achnacloich near Invergordon (T. Scott).
Orkney.—Head of Harray Loch (T. Scott).

Planorbis nitidus (Müll.).

Authenticated from six areas only, though Dr White speaks of it as "widely distributed."

Renfrew.—Paisley Canal (T. Scott).
Berwick.—Coldingham Loch (W. Evans).
Haddington.—Luffness Marshes (W. Evans).
Fife and Kinross.—Lindores Loch; Kilconquhar Loch near Elie (T. Scott).
Elgin.—Loch of Spynie (G. Gordon).
Ross E.—Loch Achnacloich near Invergordon (T. Scott).

Planorbis nautilus (L.).

The authenticated distribution, which is mainly of an eastern character, ranges as far north as Orkney.

Kirkcudbright.—High Boreland (F. R. Coles).
Renfrew.—Var. *crista*, Glasgow and Paisley Canal near Elderslie (T. Scott).
Lanark.—Hogganfield near Glasgow (A. Somerville).
Selkirk.—Var. *crista*, Haining Lake near Selkirk (W. Evans).
Haddington.—Presmennan Lake near East Linton (W. Turner). Luffness Marshes; Gullane Quarry; Gosford Ponds (W. Evans). Gullane Links (T. Scott).
Edinburgh.—Duddingston Loch (W. Evans).
Fife and Kinross.—Lindores Loch (T. Scott). Raith Lake; Tentsmuir (W. Evans).
Forfar.—Rescobie; near Montrose; var. *crista*, Montrose (W. Duncan).
Aberdeen N.—Loch Strathbeg near Fraserburgh (T. Scott).
Elgin.—Both *laevigata* and *imbricate* forms, Duffus (G. Gordon).
Easternness.—Pond near Inverness (T. Scott).
Clyde Isles.—Little Cumbrae; pool beside Loch Ascog, Bute (T. Scott).
Orkney.—Head of Harray Loch (T. Scott).

Planorbis albus Müll.

Of this—which Dr White speaks of as a "common and widely-distributed species"—the authenticated records carry

its range as far north as Sutherlandshire and Renfrewshire on the two sides of Scotland.

Kirkcudbright.—Black Stockton; Free Kirk reach, Tarff; Tongland; Dee (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Renfrew.—Paisley Canal (T. Scott).

Selkirk.—Haining Lake near Selkirk (W. Evans).

Berwick.—Coldingham Loch (W. Evans).

Haddington.—Presmennan Lake near East Linton (W. Turner). North Berwick (W. Evans).

Edinburgh.—Davidson's Mains (W. Evans).

Fife and Kinross.—Lindores Loch (T. Scott). Raith Lake (W. Evans). Loch Leven (T. Scott).

Stirling.—Loch Coulter (T. Scott).

Perth N.—Butterston Loch near Dunkeld (W. Evans).

Forfar.—Dun's Ditch near Montrose (W. Duncan).

Clyde Isles.—Loch Fad (T. Scott).

Sutherland E.—Brora (W. Baillie).

Planorbis parvus Say.

This scarce British species—very local anywhere in Britain—has been authenticated from six Scottish counties, one of them the most northerly on the mainland. Dr Jeffreys speaks of it as occurring on Unst.

Berwick.—Coldingham Loch (W. Evans).

Haddington.—Presmennan Lake near East Linton (W. Turner).

Edinburgh.—Duddingston Loch (W. Evans).

Forfar.—Loch Rescobie (W. Duncan).

Elgin.—Near Elgin (G. Gordon).

Sutherland W.—Loch near Stair Lighthouse (W. Baillie).

Planorbis spirorbis Müll.

This species is—as Dr White says—widely diffused, its authenticated records carrying its range to the northern verge of the Scottish mainland.

Kirkcudbright.—St Mary's Isle (F. R. Coles).

Renfrew.—Crosslee near Paisley; near Port Glasgow (T. Scott).

Haddington.—Bleachfield, Dunbar (T. Scott). Dunbar (W. Evans).

Edinburgh.—Marsh on Braid Hills (W. Evans).

Stirling.—Coltenhave Dam (T. Scott).

Perth N.—Near Perth (H. Coates).

Forfar.—Near Montrose (W. Duncan).

Aberdeen S.—Aberdeen (British Museum). Bridge of Don, in stomach of Shoveller (W. Evans).

Aberdeen N.—Loch Strathbeg near Fraserburgh (T. Scott).

Elgin.—Loch of Spynie (G. Gordon).

Ebudes Mid.—Tiree Island (J. E. Somerville).

Ross E.—Loch Achnacloich near Invergordon (T. Scott).

Sutherland W.—Loch near Stair Lighthouse (W. Baillie).

Planorbis vortex (L.).

Dr White speaks of this as occurring in Perthshire, Aberdeenshire, and Kircudbrightshire, and he further describes it as widely diffused. It has, however, only been submitted for authentication from two counties.

Forfar.—Dun's Ditch near Montrose (W. Duncan).

Caithness.—Loch Hempriggs near Wick (T. Scott).

Planorbis carinatus Müll.

Confined to one single Scottish locality, into which (as Dr White suggests) it has been perhaps introduced. This is the pond in the Edinburgh Botanic Garden. In England, Durham and Lancashire form its northern limit of range.

Edinburgh.—Edinburgh (W. Turner, per S. C. Cockerell).

Planorbis marginatus.

This species has only been authenticated from three Scottish counties. Its English northern range attains to Cumberland and Northumberland, so that it may be looked for throughout the southern part of Scotland.

Kirkcudbright.—Babington's Loch, Maxwelltown (R. Service). Maxwelltown (W. Evans).

Haddington.—Luffness Marshes (W. Evans).

Edinburgh.—Edinburgh (J. Stark, in Alder Collection at Newcastle Museum). Lochend (W. Turner, per S. C. Cockerell). Lochend (W. Evans).

Planorbis contortus (L.).

This species has, according to Dr Buchanan White, been found in Shetland, south of which it is widely diffused,

although its actually authenticated localities are comparatively few.

Kirkcudbright.—Tarff at Tongland; Argrennan mill-dam; Loch Finn; Black Stockton; Free Kirk reach of Tarff (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Peebles.—King's Meadows, Peebles (W. Evans).

Berwick.—Coldingham Loch (W. Evans).

Haddington.—Luffness Marshes (W. Evans).

Edinburgh.—Lochend; Duddingston Loch (W. Evans).

Fife and Kinross.—Lindores Loch; Kirkcaldy; Loch Leven (T. Scott). Otterston Loch; Raith Lake (W. Evans).

Stirling.—Loch Coulter; Bannockburn (T. Scott).

Perth Mid.—Loch Dochart (A. Somerville).

Perth N.—Near Perth (H. Coates). Butterston Loch near Dunkeld; Rae Loch near Blairgowrie (W. Evans).

Forfar.—Near Montrose (W. Duncan). Broughty Ferry (A. Somerville).

Aberdeen S.—Aberdeenshire (W. Turner, per S. C. Cockerell). Requires confirmation or further specification of locality.

Elgin.—Loch of Spynie (G. Gordon).

Easternness.—Loch Morlich (J. E. Somerville).

Clyde Isles.—Loch Greenan, Bute (W.D.R.). Loch Fad (T. Scott).

Ross E.—Loch Achnacloich near Invergordon (T. Scott).

Caithness.—Loch Hempriggs near Wick (T. Scott).

***Physa hypnorum* (L.).**

A very local species, which has been authenticated from four counties, and which Dr White records as having been found in Perthshire also.

Berwick.—Fans near Earliston (R. Renton).

Haddington.—Bleachfield, Dunbar (T. Scott). Dunbar (W. Evans).

Elgin.—Loch of Spynie (G. Gordon).

Edudes Mid.—Tiroe Island (J. E. Somerville).

***Physa fontinalis* (L.).**

This species will probably be found to occur throughout Lowland Scotland, and occurs on the east coast as far north as Forfarshire.

Kirkcudbright.—Tarff, Tongland (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Wigtown.—Ardwell (W. Evans).

Renfrew.—Cemetery Pond at Greenock (T. Scott). Paisley Canal near Glasgow (H. Nelson).

Lanark.—Glasgow and Edinburgh Canal (J. Whitwham). Possil Marsh (W.D.R.). Coathridge Canal (Hilderic Friend).

Berwick.—Coldingham Loch (W. Evans).

Haddington.—Luffness Marshes; Gosford Ponds (W. Evans).

Edinburgh.—Duddingston Loch (W.D.R.). Loch at foot of Arthur's Seat (Hilderic Friend). Lochend; small marsh near Davidson's Mains; Canal between Edinburgh and Slateford (W. Evans).

Linlithgow.—Canal at Linlithgow; Philpstoun Loch (W. Evans).

Fife and Kinross.—Lindores Loch; Kirkcaldy; Loch Leven (T. Scott). Otterston Loch (W. Evans).

Perth N.—Near Perth (H. Coates).

Forfar.—Dun's Ditch, Montrose (W. Duncan).

Clyde Isles.—Loch Fad (T. Scott).

***Limnæa peregra* (Müll.).**

This universally diffused, extremely common, and very variable species ranges throughout the kingdom of Scotland, although as yet there remain six counties (Kincardine, Westernness, Dumbarton, Ebudes S., Ross E., and Orkney) for which authenticated records are wanting.

Dumfries.—White Loch, Rockcliffe (Jessie Hele). Var. *burnetti*, Loch Skene (Miss F. M. Hele).

Kirkcudbright.—St Mary's Isle; Grange Pond; Free Kirk reach of Tarff; Ingleston mill-dam at Twynholm; Bigloch at Langbarns; stream running out of Argrennan mill-dam; Argrennan ditch (F. R. Coles). Var. *ovata*, High Clachan Loch (F. R. Coles). Maxwelltown; Castle Douglas (W. Evans).

Wigtown.—Stranraer; Lochnaw; Larbrax (Edinburgh Museum). Stranraer; Port Logan (W. Evans). Chippermere near Port William (P. Adair).

Ayr.—Dunure; Auld Brig o' Doon at Alloway; Myrenhill; Dalrymple; Irvine; Minneshant near Maybole (H. Nelson).

Renfrew.—Greenock (T. Scott). Var. *ovata*, mill-dam in Baker Street, Greenock (Andrew Scott). Greenock; Glasgow and Paisley Canal (T. Scott). Paisley, small (W. Nelson).

Lanark.—Glasgow and Edinburgh Canal (J. Whitwham). Possil Marsh (W.D.R.). River Kelvin at Summerston; and Hillhead (Alex. Shaw). Coathridge Canal (Hilderic Friend). Var. *ovata*, Blantyre; var. *ovata* (small) and var. aff. *lacustris*, in River Clyde above Rutherglen (A. Shaw).

Peebles.—River Tweed west of Holylee; var. *ovata*, River Tweed at Walkerburn (W.D.R.). Ditch by Tweed, Peebles; Lyne Farm (W. Evans).

Selkirk.—River Tweed at Holylee (W.D.R.). Haining Lake near Selkirk (W. Evans).

Roxburgh.—River Tweed at Melrose (W.D.R.). Netherhall near Hawick (W. G. Guthrie).

Berwick.—Greenlaw; Fans near Earlstoun (R. Renton). Cockburnspath; Coldingham Loch (W. Evans).

Haddington.—Pools, Dunbar (T. Scott). Presmennan Lake near East Linton (W. Turner). Pond on Rhodes Farm at North Berwick; var. *acuminata*, pond on Rhodes Farm at North Berwick; var. *maritima*, pond on Luffness Links (J. M'Murtrie). Aberlady; Gosford Ponds (W. Evans).

Edinburgh.—Duddingston Loch; Dunsappie Loch; Penicuik, etc. (Greville Collection, Edinburgh Museum). Pond in Botanic Garden at Edinburgh (W. Evans). Abundant in Braid Burn near Morningside (W. Eagle Clarke). Loch at foot of Arthur's Seat (Hilderic Friend). Var. *ovata*, Duddingston Loch (W.D.R.). Loganhouse Burn, Pentlands; near Balerno; Lochend; var. *inflata*, Canal at Slateford (W. Evans).

Linlithgow.—Newliston (Edinburgh Museum). Linlithgow Loch; Canal at Linlithgow; Philipstoun Loch (W. Evans).

Fife and Kinross.—North Queensferry (R. F. Scharff). Var. *lacustris*, Lindores Loch (T. Scott). Raith Lake; stomach of Shoveller shot at Loch Leven; Strathtyrum near St Andrews; var. *fontinalis*, Dura Den; Otterston Loch; Burntisland (W. Evans). Kirkcaldy; Kilconquhar Loch near Elie; Loch Leven (T. Scott).

Stirling.—Stirling (Greville Collection in Edinburgh Museum). Polmont (W. Evans). Coltenhave Dam; Loch Coulter; Bannockburn (T. Scott).

Perth S. with Clackmannan.—Ochil Hills and Allan Water (Edinburgh Museum).

Perth Mid.—Near Perth (H. Bendall). Crianlarich; var. *ovata*, small form, Loch Dochart (A. Somerville).

Perth N.—Var. *ovata*, near Perth (H. Coates). Rae Loch near Blairgowrie; var. *lacustris*, Loch of Clunie, between Blairgowrie and Dunkeld (W. Evans).

Forfar.—Mill-dam, Den of Fullartoun; Scurdyness; mill pond at Nether Dysart; Montrose; var. *ovata*, Scurdyness; Montrose (W. Duncan).

Aberdeen S.—Monst. *decollatum*, Aberdeen (W. Nelson). Braemar (W. Evans).

Aberdeen N.—Loch Strathbeg near Fraserburgh (T. Scott).

Banff.—Tomintoul (L. Hinxman).

Elgin.—With var. *ovata*, near Elgin (G. Gordon).

Easternness.—Nairnshire (A. Somerville). Loch Morlich (J. E. Somerville). River Spey at Kincaig by Kingussie; dub by roadside between Kincaig and Kingussie, with monst. *decollatum* (W. Evans).

Main Argyle.—Pool near Loch Awe; var. *picta*, Oban (both from Capt. Bedford, A. M. Norman). Var. *labiosa*, pond near Loch Creran (A. M. Norman).

Clyde Isles.—Rothsay (W. Nelson). Loch Fad (T. Scott). Var. *ovata*, Loch Greenan (W.D.R.).

Cantire.—Ditch and rivulets close to East Loch Tarbert (T. Scott).

Ebudes Mid.—Tiree Island (J. E. Somerville). Iona (A. Somerville). Var. *acuminata*, Mull (from Capt. Bedford, A. Merle Norman).

Ebudes N.—Eigg (A. Somerville).

Ross W.—Var. *ovata*, freshwater loch near Loch Maree (A. Somerville).

Sutherland E.—Var. *acuminata*, Mound (W. Baillie).

Sutherland W.—Stoer (J. E. Somerville). Small moorland loch near Loch Inver, small and thin specimens (A. Somerville).

Caithness.—Dunnet Sands near Thurso (W. Evans). Wick River; Loch Hempriggs (T. Scott).

Hebrides.—Loch Boisdale, South Uist (J. E. Somerville). Abundant in lochs, South Uist (A. Somerville).

Shetlands.—Shetland (W. Nelson). Var. *labiosa*, Shetland; var. *lacustris*, Unst; monst. *decollatum*, Lerwick (A. Merle Norman).

***Limnæa auricularia* (L.).**

Authenticated from several Lowland counties, and also from Fifeshire and Elginshire. The two localities which Dr White cites—Abercorn Park and Monkland Canal—have not as yet been verified by specimens submitted for authentication.

Kirkcudbright.—Bigloch, Langbarns (F. R. Coles).

Renfrew.—Paisley Canal (Greenock Museum).

Berwick.—Var. *acuta*, Greenlaw (R. Renton, per S. C. Cockerell).

Haddington.—Presmennan Lake near East Linton (W. Turner).

Edinburgh.—Canal at Edinburgh (W. Turner). St Margaret's Loch (J. Whitwham). Duddingston Loch (W.D.R.). Var. *acuta*, St Margaret's Loch (J. Whitwham). Canal near Slateford (W. Evans).

Fife and Kinross.—Lindores Loch (T. Scott).

Elgin.—Elginshire (G. Gordon).

***Limnæa stagnalis* (L.).**

Found in three localities only in Scotland, so far as yet known.

Lanark.—Old Quarry at Possil by Glasgow (T. Scott; A. Somerville).

Roxburgh.—Branxholm Loch near Hawick (W. G. Guthrie).

Haddington.—Luffness Marshes near Aberlady, small (W. Evans).

***Limnæa palustris* (Müll.).**

This species ranges southwards from Elginshire on the east and Renfrewshire on the west side of Scotland.

Kirkcudbright.—Argrennan ditch; near bridge at Glox, Tarff (F. R. Coles). Castle Douglas (W. Evans).

Renfrew.—Kilmalcolm; near Port Glasgow (T. Scott).

Lanark.—Possil Marsh (T. Scott).

Haddington.—Luffness Marshes; near North Berwick (W. Evans).

Edinburgh.—Pond at Duddingston House (W. Evans).

Linlithgow.—Philpstoun (W. Evans).

Fife and Kinross.—Linlithgow Loch: Loch Leven: T. Scott.

Perth Hill.—Near Perth: H. Benjamin.

Perth Hill.—Near Perth: H. Coates. Loch of Clack, between Blairgowrie and Dunkeld: W. Evans.

Perth.—Rear Loch: W. Duncan.

Aberdeen 2.—In stomach of Sturgeon: Loch near Bridge of Don: W. Evans.

Aberdeen 2.—Huntly: J. Goudier. Loch Strathairn: T. Scott.

Edin.—Loch of Spring: J. Goudier.

Limnaea truncatula Mill.

This species will probably be ultimately found in every natural area through which it has been introduced from twenty-five counties only. The records however, show that it ranges throughout the kingdom, and Dr White describes it as "common and widely distributed."

Edinburgh.—Blackfriars: F. I. Jones. Loch Leven: W. Evans. Loch of Clack: H. Coates. Loch Strathairn: H. Coates. Loch of Spring: J. Goudier.

Edin.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates. Loch of Clack: H. Coates. Loch Leven: W. Evans.

Edin.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates.

Edin.—Loch of Spring: J. Goudier.

Edin.—Loch of Spring: J. Goudier.

Edinburgh.—Loch of Spring: J. Goudier.

Edinburgh.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates. Loch of Clack: H. Coates. Loch Leven: W. Evans.

Edinburgh.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates. Loch of Clack: H. Coates. Loch Leven: W. Evans.

Edin.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates. Loch of Clack: H. Coates. Loch Leven: W. Evans.

Edin.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates.

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Edin.—Loch of Spring: J. Goudier.

Edin.—Loch of Spring: J. Goudier.

Edin.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates. Loch of Clack: H. Coates. Loch Leven: W. Evans.

Edin.—Loch of Spring: J. Goudier. Loch Strathairn: H. Coates.

Edin.—Loch of Spring: J. Goudier.

Ebudes N.—Eigg (A. Somerville).

Sutherland E.—Mound ; Brora (W. Baillie).

Sutherland W.—Extends over nearly all Sutherland (W. Baillie). Confirmation needed.

Caithness.—Dunbeath Castle (W. Baillie). Loch Hempriggs (T. Scott).

***Limnæa glabra* (Müll.).**

This species is, as Dr White describes it, rare and local. Of the two stations which he mentions, however, specimens have only been seen from one. The Perthshire record still remains to be authenticated.

Lanark.—Frankfield Loch near Glasgow (T. Scott).

***Ancylus fluviatilis* Müll.**

This is a species which may be expected ultimately to be found in every comital area, ranging, as the records already show, throughout Scotland.

Kirkcudbright.—Culdoch Burn ; Tongland Dam ; Tarff at Ringford ; var. *albida*, Tarff (F. R. Coles). Castle Douglas (W. Evans).

Wigtown.—Piltanton burn near Stranraer (W. Evans).

Ayr.—Myrenhill by Ayr ; Crossraguel Abbey ; Minneslant by Maybole (H. Nelson). Largs (A. Shaw).

Renfrew.—Cut flowing into dam, Baker Street, Greenock (Andrew Scott). Ditches and rivulets about Greenock (T. Scott).

Lanark.—Coatbridge (Hilderic Friend).

Peebles.—Near Peebles (A. Somerville). West Linton ; Eddleston Water (W. Evans).

Selkirk.—River Tweed at Holylee and Elibank (W.D.R.).

Berwick.—Coldingham Loch (W. Evans).

Haddington.—Stream at Ballincrieff near Aberlady ; North Berwick (W. Evans).

Edinburgh.—Braidburn near Edinburgh ; Logan burn, Pentlands ; near Balerno (W. Evans).

Linlithgow.—Stream entering Linlithgow Loch ; var. *gibbosa*, Linlithgow Loch (W. Evans).

Fife and Kinross.—St Andrews ; Strathtyrum near St Andrews ; Raith Lake ; Burntisland (W. Evans).

Stirling.—Bannockburn (T. Scott).

Perth N.—Near Perth (H. Coates).

Forfar.—Usan near Montrose (W. Duncan).

Aberdeen S.—Aberdeenshire (W. Turner). Braemar (W. Evans).

Elgin.—Near Elgin (G. Gordon).

Main Argyll.—Glen Morag near Dunoon (W.D.R.).

Dumbarton.—Crosslet by Dumbarton (W.D.R.). Garscadden (Alex. Shaw).

Clyde Isles.—Brodick, Arran (A. Somerville). Loch Fad, Bute (T. Scott).

Cantira.—North side of West Loch, Tarbert (T. Scott).

Ebudes N.—Eigg (A. Somerville).

Sutherland W.—East of Kyle of Tongue (W. Baillie).

***Ancylus lacustris* (L.).**

This species is local. It is recorded by Dr White for three counties (Edinburghshire in Duddingston Loch, Perthshire, and Aberdeenshire), from one of which specimens have not as yet been submitted for authentication.

Kirkcubright.—The Tarff at Ringford (F. R. Coles).

Lanark.—Fossil Marsh (F. G. Binnie).

Haddington.—Gosford Ponds; near North Berwick (W. Evans).

Edinburgh.—With var. *albida* and *moynisiana*, marsh near Davidson's Maus (W. Evans).

Fife and Kinross.—Lindores Loch (T. Scott). Otterston Loch (W. Evans).

Forfar.—Loch Rescobie (W. Duncan).

Aberdeen N.—St Fergus Canal near Peterhead (W. Dawson, per G. Gordon).

***Sphaerium corneum* (L.).**

This species ranges throughout the kingdom, even as far as Shetland. Two counties mentioned by Dr White (Aberdeenshire and Inverness-shire) have as yet not been represented by authenticated specimens.

Kirkcubright.—Loch Firth; Angreunan ditch (F. R. Coles). Castle Douglas; Maxwelltown (W. Evans).

Renfrew.—Paisley Canal (J. Couscher). Glasgow and Paisley Canal (T. Scott).

Berwick.—Firth near Earlston (R. Benton). Coldingham Loch (W. Evans).

Haddington.—Luffness Marshes (W. Evans).

Edinburgh.—St Margaret's Loch (J. Whitwham). Lochend; Braid Hills; Marsh near Davidson's Maus; Canal near Slateford, with var. *fuscicornis*; Duddingston Loch (W. Evans).

Linhithgow.—Canal at Linlithgow, with var. *fuscicornis* (W. Evans).

Fife and Kinross.—Loch Leven; Ruth Lake; Baratisland; Otterston Loch (W. Evans). Kirkcaldy; Loch Leven (T. Scott).

Stirling.—Loch Coulter (T. Scott).

Perth Mid.—Near Perth (H. Bendall).

Perth N.—Near Perth (H. Coates). Butterston Loch near Dunkeld (W. Evans).

Forfar.—Dun's Ditch near Montrose; Loch Rescobie; var. *nucleus*, Dun's Ditch (W. Duncan).

Elgin.—Near Elgin (G. Gordon).

Caithness.—Loch Hempriggs near Wick (T. Scott).

Shetland.—Var. *flavescens*, Lerwick (A. Merle Norman).

Sphærium lacustre (Müll.).

This species has been placed on record for near Glasgow, in addition to the four counties from which we have seen specimens. It is evidently very local and rare.

Haddington.—Gosford Ponds (W. Evans). Barryhill Quarry near Dunbar (T. Scott).

Edinburgh.—Specimen in British Museum labelled "near Edinburgh" (J. W. Taylor).

Fife and Kinross.—Burntisland (W. Evans).

Ross E.—Invergordon (T. Scott).

Pisidium amnicum (Müll.).

This species—described by Dr White as widely distributed—has so far been authenticated for four Scottish localities only.

Renfrew.—Glasgow and Paisley Canal (T. Scott).

Stirling.—Loch Coulter (T. Scott).

Perth S. with Clackmannan.—The Allan, Dunblane (Janet Carphin).

Dumbarton.—Loch near Forth and Clyde Canal, Maryhill (A. Shaw).

Pisidium fontinale (Drap.).

Of this species—spoken of by Dr White as being common and widely distributed—we have authenticated records for sixteen counties.

Kirkcudbright.—Black Stockton mill-dam (F. R. Coles). Maxwelltown (W. Evans).

Peebles.—Pond on Lyne Farm (W. Evans).

Berwick.—Cockburnspath (W. Evans).

Haddington.—Gosford Ponds (W. Evans).

Edinburgh.—Duddingston Loch; near Balerno; Craiglockhart Skating Pond (W. Evans).

- Edinburgh.**—Marsh. Braud Hills; Duddingston Loch (W. Evans).
Fife and Kinross.—Lundies Loch (T. Scott). From stomachs of Shovellers shot at Loch Leven; Otterston Loch (W. Evans).
Perth Mid.—Loch Tachart, all 500 feet, at roots of *Chara*; Crianlarich (A. Somerville).
Elgin.—Near Elgin (G. Gordon).
Easternness.—Loch Morich, Inverness (J. E. Somerville). Pond near Inverness (T. Scott).
Don E.—Loch Achnacloch near Invergordon (T. Scott).
Orkney.—Head of Harray Loch (T. Scott).

***Unio margaritifer* (L.).**

This is one of the very few instances of Mollusca with a northern range—being common and widely distributed in Ireland and Scotland, and restricted in England to a few stations in the northern counties and in Wales.

- Renfrew.**—River Gryfe near Kilmalcolm, a single example dug up about a foot deep in the bed of the river (Greenock Museum).
Leamark.—River Clyde near Cambuslang (T. Scott).
Perth E. with Clackmannan.—Trossachs (Thomas Rogers).
Perth Mid.—River Tummel (J. Hardy, sen.). River Tay, Perth (T. Rogers). River Lyon (T. Scott).
Forfar.—River Pow, Kinnard House Farm, half a mile from South Esk (W. Duncan).
Elgin.—Elginshire (G. Gordon).
Easternness.—River Spey at Kincaig by Kingussie (W. Evans).
Main Argyle.—River Onchy, near where it flows into Loch Awe (A. Somerville).
Sutherland W.—Var. *sinuata*, near Stair Point, Assynt (W. Baillie).

***Anodonta cygnea* (L.).**

Local in Scotland. The Perthshire locality mentioned by Dr White is one from which our referees have not yet seen examples.

- Renfrew.**—Glasgow and Paisley Canal near Elderslie; var. *radiata*, Paisley Canal (T. Scott). Var. *incrassata*, Paisley Canal (Greenock Museum).
Edinburgh.—Lochend (W. Evans).
Fife and Kinross.—Raith Lake (W. Evans). Loch Leven (T. Scott).
Forfar.—A slow deep running stream near Montrose (W. Duncan).
Elgin.—Elginshire (G. Gordon).

Anodonta anatina (L.).

Authenticated for two localities only.

Haddington.—Gosford Ponds (W. Evans).

Edinburgh.—Near Edinburgh (W. Turner). Lochend (W. Evans).

Dreissena polymorpha (Pall.).

Local. Confined to canals near Glasgow and Edinburgh.

Renfrew.—Paisley Canal (A. Somerville).

Lanark.—Forth and Clyde Canal near Glasgow (T. Scott).

Edinburgh.—Union Canal at Meggatland near Edinburgh (W. Evans).

I will conclude the paper by a table showing at a glance for what counties each species has been authenticated, how many species have been recorded for each county, and how many counties for each species; and by asking Scottish naturalists to co-operate in submitting specimens for every county and species marked with a dash in the table. It is desirable that particular attention be paid to sending living slugs for identification, as there are no existing text-books in which these are correctly described.

[TABLE SHOWING DISTRIBUTION OF SPECIES.]

NAME OF SPECIES.	West Lowlands.							East Lowlands.							East Highlands.										
	72 Dumfries.	73 Kirkcudbright.	74 Wigtown.	75 Ayr.	76 Renfrew.	77 Lanark.		78 Peebles.	79 Selkirk.	80 Roxburgh.	81 Berwick.	82 Haddington.	83 Edinburgh.	84 Linlithgow.	85 Fife and Kinross.	86 Stirling.	87 Perth S. & Clk'm'n.	88 Perth Mid.	89 Perth N.	90 Forfar.	91 Kincardine.	92 Aberdeen S.	93 Aberdeen N.	94 Banff.	95 Elgin.
<i>Arion ater</i> ,	72 73	74 75	76 77					78 79	-	81 82	83 84				85 86	87 88	89 90	91 92	93	-	-	-	-	-	-
<i>A. subfuscus</i> ,	72 73	-	-	-	77			78 79	-	81 82	83 84				85	-	-	89	-	91 92	-	-	-	-	-
<i>A. hortensis</i> ,	72 73	74 75	76 77					78 79	-	81 82	83 84				85 86	-	88	-	90	-	-	-	94	-	-
<i>A. bourguignati</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	87 88	89 90	91 92	-	94	95	-	-	-	-
<i>A. minimus</i> ,	72	-	75	-	-			-	-	81 82	83 84				-	-	89	-	-	-	-	-	95	-	93
<i>Amalia gagates</i> ,	-	-	-	-	-			-	-	81	83	-			-	-	-	-	-	-	-	-	-	-	-
<i>A. carinata</i> ,	-	-	-	76	-			-	-	-	83	-			85	-	-	-	-	-	-	-	-	-	-
<i>Limax maximus</i> ,	-	73 74	75 76	-	-			78 79	80	81 82	83	-			85 86	-	88 89	90	-	-	93	-	-	-	-
<i>L. cinereo-niger</i> ,	-	-	-	-	-			-	-	-	-	-			-	-	-	90	-	-	-	-	-	-	-
<i>L. arborum</i> ,	-	-	-	-	-			78 79	-	81 82	83	-			85 86	-	88 89	-	91	-	93	-	-	-	-
<i>L. flavus</i> ,	-	-	-	76	-			-	-	-	83	-			85	-	-	-	-	-	-	-	-	-	95
<i>Agriolimax agrestis</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	87 88	89 90	91 92	93	94	95	-	-	-	-
<i>A. levis</i> ,	72	-	-	76	-			78	-	-	82 83	84			85	-	-	89	-	92	-	-	-	-	-
<i>Testacella haliotidea</i> ,	-	73	-	-	-			-	-	-	-	-			-	-	-	-	-	-	-	-	-	-	-
<i>T. scutulum</i> ,	-	-	-	-	-			-	-	-	-	-			85	-	-	-	-	-	-	-	-	-	-
<i>Succinea putris</i> ,	-	73	-	75 76	77			78 79	80	-	82 83	-			85	-	-	89 90	91	-	-	-	95	-	-
<i>S. elegans</i> ,	-	73	-	-	-			-	-	-	82 83	-			85	-	-	89	-	-	-	-	-	-	-
<i>S. oblonga</i> ,	-	-	-	75	-			-	-	-	-	84			-	-	-	89	-	-	-	-	-	-	-
<i>Vitina pellucida</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	87 88	89 90	91 92	-	94	95	-	-	-	-
<i>Zonites draparnaldi</i> ,	-	-	-	-	-			-	-	-	-	-			85	-	-	-	91	-	-	-	-	-	-
<i>Z. cellarius</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	87 88	89 90	91 92	-	94	95	-	-	-	-
<i>Z. alliarius</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85	-	87 88	89 90	-	92	-	94	95	-	-
<i>Z. glaber</i> ,	-	-	75	-	-			-	-	-	-	-			-	-	-	-	-	-	-	-	-	-	-
<i>Z. nitidulus</i> ,	72 73	74 75	76 77					78	-	80	81 82	83 84			85 86	87 88	89 90	91 92	-	94	95	-	-	-	-
<i>Z. purus</i> ,	72 73	-	75 76	-	-			-	-	80	81 82	83	-		85	-	87 88	89 90	91	-	-	-	95	-	-
<i>Z. radiatulus</i> ,	72	-	-	76 77	-			-	-	-	83 84	-			85	-	87	89 90	-	92	-	95	-	-	-
<i>Z. nitidus</i> ,	-	-	-	-	-			-	-	-	-	-			-	-	89	-	-	-	-	-	-	-	-
<i>Z. excavatus</i> ,	-	-	74	-	76	-		-	-	-	-	-			-	86 87	-	-	-	-	-	-	-	-	-
<i>Z. crystallinus</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	87 88	89 90	91	-	-	94	95	-	-	-
<i>Z. fulvus</i> ,	-	73 74	75 76	77	-			78 79	-	81 82	83 84				85	-	87 88	89 90	91	-	-	-	95	-	-
<i>Helix lamellata</i> ,	-	73	-	75	-			-	-	-	-	-			-	86	-	88	-	-	-	-	-	-	-
<i>H. aculeata</i> ,	-	73	-	75 76	-			-	79	-	81 82	83	-		85	-	-	89 90	-	-	-	-	95	-	-
<i>H. aspersa</i> ,	72 73	74 75	76	-	-			78	-	80	81 82	83 84			85	-	-	89 90	-	-	-	94	95	-	-
<i>H. nemoralis</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	-	88 89	90	-	-	-	-	-	-	-
<i>H. hortensis</i> ,	-	73	-	75 76	77			-	-	80	81 82	83	-		85 86	-	88 89	90	91 92	-	94	95	-	-	-
<i>H. arbustorum</i> ,	72	-	-	75 76	77			-	-	80	-	82 83	84		85 86	-	88	-	90 91	92	-	94	95	-	-
<i>H. rufescens</i> ,	-	73	-	76	-			-	-	80	-	-	-		-	-	-	-	-	-	-	-	-	-	-
<i>H. concinna</i> ,	-	73	-	75	-	77		78	-	-	81 82	83	-		85 86	-	-	89	-	91	-	-	-	-	-
<i>H. hispida</i> ,	-	73	-	75 76	77			78 79	80	81 82	83 84				85 86	-	-	88 89	90 91	-	-	-	-	-	-
<i>H. sericea</i> ,	-	-	-	75 76	-			-	-	-	83	-			-	-	-	90 91	-	-	-	-	95	-	-
<i>H. fusca</i> ,	72 73	-	75 76	77	-			78	-	80	-	83	-		-	-	88	-	90	-	92	-	-	-	-
<i>H. virgata</i> ,	-	-	-	75	-			-	-	-	-	-			-	-	-	-	-	-	-	-	-	-	-
<i>H. caperata</i> ,	-	-	74 75	-	77			-	-	-	81 82	83 84			85 86	-	-	-	90	-	92	-	-	95	-
<i>H. ericetorum</i> ,	-	-	-	-	-			-	-	-	-	-			85	-	-	-	-	-	-	-	-	-	-
<i>H. rotundata</i> ,	72 73	74 75	76 77					78 79	80	81 82	83 84				85 86	87 88	89 90	91 92	-	-	-	95	-	-	-
<i>H. rupestris</i> ,	-	-	-	-	-			-	-	-	83	-			-	-	89	-	-	-	-	-	-	-	-
<i>H. pygmaea</i> ,	-	73	-	75	-	-		78	-	-	81 82	83	-		85 86	87	-	89	-	-	93	-	-	-	-
<i>H. pulchella</i> ,	-	-	-	-	-			-	-	-	81 82	83 84			85	-	-	89 90	91	-	-	-	95	-	-
<i>H. lapicida</i> ,	-	-	-	-	-			-	-	80	-	-			-	-	-	-	-	-	-	-	-	-	-
<i>Bulimus acutus</i> ,	-	-	74 75	-	-			-	-	-	-	-			-	-	-	-	-	-	-	-	-	-	-
<i>B. obscurus</i> ,	-	-	-	-	77			-	-	-	81 82	83 84			-	-	88 89	90 91	-	-	94	95	-	-	-
<i>Pupa ringens</i> ,	-	-	-	75 76	-			-	-	-	-	-			85	-	-	-	91	-	-	-	-	-	-
<i>P. umbilicata</i> ,	72 73	74 75	76	-	-			78	-	80	81 82	83 84			85 86	87	-	89 90	91	-	-	94	95	-	-
Count forward,	20 28 18 83 30 22								23 17 20 28 31 38 24								36 21 15 21 31 28 23 15								

West Highlands.					North Highlands.					Isles.			NAME OF SPECIES.	
99 Dumbarton.	100 Clyde Isles.	101 Cantire.	102 Ebudes S.	103 Ebudes Mid.	104 Ebudes N.	105 Ross W.	106 Ross E.	107 Sutherland E.	108 Sutherland W.	109 Caithness.	110 Hebrides.	111 Orkneys.		112 Shetlands.
8 99 100 101 102 103	-	-	-	-	-	-	-	107 108 109	110 - 102	-	-	-	-	<i>Arion ater</i> , . . . 34 counties.
8 99 100 101	-	-	-	-	-	105	-	107 -	-	-	-	-	-	<i>A. subfuscus</i> , . . . 18 "
8 99 100	-	-	-	-	104 105	-	-	107 108 109	110 111	-	-	-	-	<i>A. hortensis</i> , . . . 29 "
8 99 100 - 102 103	-	-	-	-	104 -	-	-	107 108 -	110 111	-	-	-	-	<i>A. bourguignati</i> , . . . 35 "
8 99 100	-	-	-	-	104 -	-	-	-	-	111	-	-	-	<i>A. minimus</i> , . . . 12 "
8 99 100	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Amalia gagates</i> , . . . 3 "
8 99 100	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>A. carinata</i> , . . . 4 "
8 99 100 - 102	-	-	-	-	-	-	-	107 -	-	-	-	-	-	<i>Limax maximus</i> , . . . 22 "
-	-	-	-	-	-	-	-	107 -	-	-	-	-	-	<i>L. cinereo-niger</i> , . . . 3 "
-	-	-	-	-	-	-	-	107 - 109	-	-	-	-	-	<i>L. arborum</i> , . . . 14 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>L. flavus</i> , . . . 4 "
8 99 100 101 102 103	104 105	106	107	108 109	110 111 112	-	-	-	-	-	-	-	-	<i>Agriolimax agrestis</i> , . . . 41 "
8 99 100 101	-	-	-	-	-	-	-	107 108 109	-	-	-	-	-	<i>A. lævis</i> , . . . 16 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Testacella haliotideq</i> , . . . 1 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>T. scutulum</i> , . . . 1 "
-	100	-	-	-	-	-	-	-	109	-	-	-	-	<i>Succinea putris</i> , . . . 16 "
-	100	-	-	-	-	-	-	-	-	-	-	-	-	<i>S. elegans</i> , . . . 6 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>S. oblonga</i> , . . . 2 "
8 99 100 - 103	-	105 106	107	108 109	110 111	-	-	-	-	-	-	-	-	<i>Vitrina pellucida</i> , . . . 35 "
-	100	-	-	-	-	-	-	-	-	-	-	-	-	<i>Zonites draparnaldi</i> , . . . 3 "
8 99 100 101 - 103	-	105 106	107 - 109	110 -	-	-	-	-	-	-	-	-	-	<i>Z. cellarius</i> , . . . 34 "
8 99 100 101 - 103	-	105 106	107 108 109	110 111 112	-	-	-	-	-	-	-	-	-	<i>Z. alliarius</i> , . . . 35 "
8 99 100	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Z. glaber</i> , . . . 3 "
8 99 100 101 102 -	104 105 106	-	-	109	-	-	-	-	-	-	-	-	-	<i>Z. nitidulus</i> , . . . 81 "
8 99 100 101 -	-	105 -	107 - 109	-	-	-	-	-	-	-	-	-	-	<i>Z. purus</i> , . . . 24 "
8 99 100 101 -	-	-	-	109	-	-	-	-	-	-	-	-	-	<i>Z. radiatulus</i> , . . . 16 "
-	100	-	-	-	-	-	-	-	-	-	-	-	-	<i>Z. nitidus</i> , . . . 3 "
-	100	-	-	-	-	-	-	-	-	-	-	-	-	<i>Z. excavatus</i> , . . . 5 "
8 99 100 101 -	-	105 -	107 - 109	-	-	-	-	-	-	-	-	-	-	<i>Z. crystallinus</i> , . . . 30 "
8 99 100 101 -	-	105 -	107 108 109	-	-	-	-	-	-	-	-	-	-	<i>Z. fulvus</i> , . . . 26 "
8 99 100 -	-	-	108 107 -	-	-	-	-	-	-	-	-	-	-	<i>Helix lamellata</i> , . . . 8 "
8 99 100 101 102 103	-	-	107 - 109	-	-	-	-	-	-	-	-	-	-	<i>H. aculeata</i> , . . . 14 "
8 99 100 101 102 103	-	-	-	-	-	-	-	-	110 -	-	-	-	-	<i>H. aspersa</i> , . . . 24 "
8 99 - - 103	-	-	-	-	-	-	-	-	110 -	-	-	-	-	<i>H. nemoralis</i> , . . . 26 "
8 99 100 101 -	-	106 107	108 109	110 -	-	-	-	-	110 -	-	-	-	-	<i>H. hortensis</i> , . . . 26 "
8 99 100 101 -	-	105 106	107 108 109	-	111 112	-	-	-	-	-	-	-	-	<i>H. arbustorum</i> , . . . 27 "
8 99 - 101 -	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. rufescens</i> , . . . 6 "
8 99 100 -	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. concinna</i> , . . . 14 "
8 99 100 101 -	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. hispida</i> , . . . 21 "
8 99 - 100 101 - 103	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. sericea</i> , . . . 10 "
8 99 - 100 101 -	-	-	106 107 -	-	-	-	-	-	-	-	-	-	-	<i>H. fusca</i> , . . . 16 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. virgata</i> , . . . 1 "
-	100 101 -	-	-	-	-	-	-	107 108 -	-	-	-	-	-	<i>H. caperata</i> , . . . 17 "
-	100 101 - 103	-	-	-	-	-	-	108 109	110 -	-	-	-	-	<i>H. ericetorum</i> , . . . 8 "
8 99 100 101 - 103	104 105	106	107	108 109	-	-	-	-	-	-	-	-	-	<i>H. rotundata</i> , . . . 34 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. rupestris</i> , . . . 2 "
-	100	-	-	-	-	105 -	-	107 108 109	-	-	-	-	-	<i>H. pygmaea</i> , . . . 17 "
-	100 101 -	-	-	-	104 -	-	-	107 -	-	-	-	-	-	<i>H. pulchella</i> , . . . 14 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>H. lapicida</i> , . . . 1 "
-	-	101 - 103	-	-	104 -	-	-	108 109	110 -	-	-	-	-	<i>Bulimus acutus</i> , . . . 8 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>B. obscurus</i> , . . . 11 "
8 99 - 101 -	-	-	106 107 108 -	-	-	-	-	-	-	-	-	-	-	<i>Pupa ringens</i> , . . . 9 "
8 99 100 101 - 103	-	105 106	107 108 109	110 -	-	-	-	-	-	-	-	-	-	<i>P. umbilicata</i> , . . . 31 "
29 24 38 25 7 14	8	14	12	26	17	22			13	7	4			= 851

NAME OF SPECIES.	West Lowlands.							East Lowlands.							East Highlands.									
	72 Dumbries.	73 Kirkcudbright.	74 Wigtown.	75 Ayr.	76 Renfrew.	77 Lanark.	78 Peebles.	79 Selkirk.	80 Roxburgh.	81 Berwick.	82 Haddington.	83 Edinburgh.	84 Linlithgow.	85 Fife and Kinross.	86 Stirling.	87 Perth S. & Clackm'n.	88 Perth Mid.	89 Perth N.	90 Forfar.	91 Kincardine.	92 Aberdeen S.	93 Aberdeen N.	94 Banff.	
Brought forward,	20	28	18	33	30	22	23	17	20	28	31	38	24	36	21	15	21	31	28	23	15	5	13	4
<i>Pupa marginata</i> , . . .	-	-	-	-	-	-	-	-	-	-	82	83	-	85	-	-	-	-	-	91	-	-	-	-
<i>Vertigo antivertigo</i> , . . .	-	-	-	-	-	-	-	-	-	81	82	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>V. pygmaea</i> , . . .	-	-	-	75	76	-	78	79	-	-	82	83	-	-	-	-	-	-	-	91	-	-	-	-
<i>V. substriata</i> , . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	85	-	-	-	-	-	-	-	-	-	-
<i>V. pusilla</i> , . . .	-	73	-	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>V. angustior</i> , . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>V. edentula</i> , . . .	-	-	-	75	76	-	78	-	-	81	82	83	-	85	86	87	-	89	90	91	-	-	-	-
<i>V. minutissima</i> , . . .	-	-	-	-	-	-	-	-	-	-	82	83	-	-	-	-	-	-	-	-	-	-	-	-
<i>Balea perversa</i> , . . .	-	73	-	75	-	-	-	79	80	81	82	83	-	85	86	-	88	89	-	91	-	-	94	9
<i>Clausilia rugosa</i> , . . .	-	73	74	75	76	77	-	-	80	-	82	83	-	85	86	87	88	89	90	91	-	-	94	9
<i>Cl. laminata</i> , . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	89	-	-	-	-	-	-	-
<i>Azecla tridens</i> , . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	87	-	-	-	-	-	-	-	-
<i>Zua lubrica</i> , . . .	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	-	88	89	90	91	92	-	94	9
<i>Carychium carychium</i> , . . .	-	73	74	75	76	77	78	79	-	81	82	83	84	85	-	87	-	89	90	91	-	-	-	9
<i>Acme lineata</i> , . . .	-	-	-	75	76	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Bythinia tentaculata</i> , . . .	-	73	-	-	76	77	-	-	-	-	-	83	84	-	-	-	-	-	-	-	-	-	-	-
<i>Valvata piscinalis</i> , . . .	-	73	-	-	76	-	-	-	-	-	82	83	-	85	86	-	-	89	90	-	-	-	-	-
<i>V. cristata</i> , . . .	-	73	-	-	77	-	-	-	-	-	82	83	-	85	-	-	-	90	-	-	-	-	-	-
<i>Planorbis nitidus</i> , . . .	-	-	-	-	76	-	-	-	-	81	82	-	-	85	-	-	-	-	-	-	-	-	-	9
<i>Pl. nautilius</i> , . . .	-	73	-	-	76	77	-	79	-	-	82	83	-	85	-	-	-	90	-	-	93	-	9	
<i>Pl. albus</i> , . . .	-	73	-	-	76	-	-	79	-	81	82	83	-	85	86	-	-	89	90	-	-	-	-	-
<i>Pl. parvus</i> , . . .	-	-	-	-	-	-	-	-	-	81	82	83	-	-	-	-	-	90	-	-	-	-	-	9
<i>Pl. spirorbis</i> , . . .	-	73	-	-	76	-	-	-	-	-	82	83	-	-	86	-	-	89	90	-	92	93	-	9
<i>Pl. vortex</i> , . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	90	-	-	-	-	-	-
<i>Pl. carinatus</i> , . . .	-	-	-	-	-	-	-	-	-	-	83	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pl. marginatus</i> , . . .	-	73	-	-	-	-	-	-	-	-	82	83	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pl. contortus</i> , . . .	-	73	-	-	-	-	78	-	-	81	82	83	-	85	86	-	88	89	90	-	92	-	-	9
<i>Physa hypnorum</i> , . . .	-	-	-	-	-	-	-	-	-	81	82	-	-	-	-	-	-	-	-	-	-	-	-	9
<i>P. fontinalis</i> , . . .	-	73	74	-	76	77	-	-	-	81	82	83	84	85	-	-	89	90	-	-	-	-	-	-
<i>Limnaea peregra</i> , . . .	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	-	92	93	94	9
<i>L. auricularia</i> , . . .	-	73	-	-	76	-	-	-	-	81	82	83	-	85	-	-	-	-	-	-	-	-	-	9
<i>L. stagnalis</i> , . . .	-	-	-	-	77	-	-	-	80	-	82	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. palustris</i> , . . .	-	73	-	-	76	77	-	-	-	-	82	83	84	85	-	-	88	89	90	-	92	93	-	9
<i>L. truncatula</i> , . . .	-	73	-	75	76	77	78	79	80	-	82	83	-	85	86	87	-	89	90	91	92	-	94	9
<i>L. glabra</i> , . . .	-	-	-	-	77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ancylus fluviatilis</i> , . . .	-	73	74	75	76	77	78	79	-	81	82	83	84	85	86	-	-	89	90	-	92	-	-	9
<i>A. lacustris</i> , . . .	-	73	-	-	77	-	-	-	-	-	82	83	-	85	-	-	-	90	-	-	93	-	-	-
<i>Sphaerium corneum</i> , . . .	-	73	-	-	76	-	-	-	-	81	82	83	84	85	86	-	88	89	90	-	-	-	-	9
<i>S. lacustre</i> , . . .	-	-	-	-	-	-	-	-	-	-	82	83	-	85	-	-	-	-	-	-	-	-	-	-
<i>Pisidium amnicum</i> , . . .	-	-	-	-	76	-	-	-	-	-	-	-	-	-	86	87	-	-	-	-	-	-	-	-
<i>P. fontinale</i> , . . .	-	73	-	-	-	-	78	-	-	81	82	83	84	85	86	-	-	89	90	-	92	-	-	9
<i>P. pulchellum</i> , . . .	-	73	74	-	-	-	78	-	-	-	82	-	-	85	-	87	-	-	90	-	-	-	-	-
<i>P. cinereum</i> , . . .	-	-	-	-	76	-	-	-	-	-	-	-	-	85	-	-	-	-	-	-	-	-	-	-
<i>P. pusillum</i> , . . .	-	73	-	-	-	-	78	-	-	81	82	83	84	85	86	87	-	-	90	-	92	-	-	9
<i>P. nitidum</i> , . . .	72	-	-	-	-	-	-	-	-	-	82	83	-	85	-	-	89	-	-	92	-	94	9	
<i>P. roseum</i> , . . .	-	73	-	-	-	-	-	79	-	-	82	83	-	85	-	-	88	-	-	-	-	-	-	9
<i>Unio margaritifera</i> , . . .	-	-	-	-	76	77	-	-	-	-	-	83	-	-	87	88	-	90	-	-	-	-	-	9
<i>Anodonta cygnea</i> , . . .	-	-	-	-	76	-	-	-	-	-	-	83	-	85	-	-	-	90	-	-	-	-	-	9
<i>A. anatina</i> , . . .	-	-	-	-	-	-	-	-	-	-	82	83	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dreissena polymorpha</i> , . . .	-	-	-	-	76	77	-	-	-	-	-	83	-	-	-	-	-	-	-	-	-	-	-	-
Total, . . .	23	53	25	44	54	38	34	27	26	45	66	72	34	65	36	25	30	49	52	31	25	10	19	4

West Highlands.					North Highlands.						Isles.			NAME OF SPECIES.
98 Dumbarton.	100 Clyde Isles.	101 Cantire.	102 Ehudes S.	103 Ebudes Mid.	104 Ebudes N.	105 Ross W.	106 Ross E.	107 Sutherland E.	108 Sutherland W.	109 Caithness.	110 Hebrides.	111 Orkneys.	112 Shetlands.	
24	38	25	7	14	8	14	12	26	17	22	13	7	4	= 851
-	100	-	-	-	-	-	-	-	108	-	-	-	-	<i>Pupa marginata</i> , . . . 7 counties.
-	100	-	-	-	-	-	-	106	107	-	-	-	-	<i>Vertigo antiveritigo</i> , . . . 6 "
-	100	-	-	-	-	105	-	-	-	109	-	-	-	<i>V. pygmaea</i> , . . . 12 "
-	100	-	-	-	-	-	-	-	107	-	-	-	-	<i>V. substriata</i> , . . . 3 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>V. pusilla</i> , . . . 2 "
-	100	101	-	-	-	-	-	-	107	-	-	-	-	<i>V. angustior</i> , . . . 1 "
-	-	-	-	-	-	-	-	-	107	108	109	-	-	<i>V. edentula</i> , . . . 18 "
-	100	101	-	-	-	-	-	-	107	-	109	-	-	<i>V. minutissima</i> , . . . 2 "
-	100	101	-	-	-	-	-	-	107	-	109	-	-	<i>Balea perversa</i> , . . . 19 "
99	100	101	-	103	-	105	-	-	107	108	109	-	-	<i>Clausilia rugosa</i> , . . . 27 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Cl. laminata</i> , . . . 1 "
99	100	101	-	103	-	105	106	107	108	109	110	-	112	<i>Azeca tridens</i> , . . . 1 "
-	100	101	-	-	-	-	-	-	107	-	-	-	-	<i>Zua lubrica</i> , . . . 36 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Carychium carychium</i> , . . . 21 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Acme lineata</i> , . . . 2 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Bythinia tentaculata</i> , . . . 5 "
-	-	-	-	-	-	-	106	-	-	-	-	-	-	<i>Valvata piscinalis</i> , . . . 8 "
-	100	-	-	-	-	-	106	-	-	-	111	-	-	<i>V. cristata</i> , . . . 8 "
-	100	-	-	-	-	-	-	-	-	-	111	-	-	<i>Planorbis nitidus</i> , . . . 6 "
-	-	-	-	-	-	-	-	107	-	-	-	-	-	<i>Pl. nautilicus</i> , . . . 13 "
-	-	-	-	-	-	-	-	-	108	-	-	-	-	<i>Pl. albus</i> , . . . 12 "
-	-	-	-	103	-	-	106	-	108	-	-	-	-	<i>Pl. parvus</i> , . . . 6 "
-	-	-	-	-	-	-	-	-	-	109	-	-	-	<i>Pl. spirorbis</i> , . . . 13 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Pl. vortex</i> , . . . 2 "
-	100	-	-	-	-	-	-	-	-	-	-	-	-	<i>Pl. carinatus</i> , . . . 1 "
-	-	-	-	103	-	-	106	-	-	109	-	-	-	<i>Pl. marginatus</i> , . . . 3 "
-	100	-	-	-	-	-	-	-	-	-	-	-	-	<i>Pl. contortus</i> , . . . 16 "
-	100	-	-	103	-	-	-	-	-	-	-	-	-	<i>Physa hypnorum</i> , . . . 4 "
-	100	101	-	103	104	105	-	107	108	109	110	-	112	<i>P. fontinalis</i> , . . . 12 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Limnæa peregra</i> , . . . 35 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>L. auricularia</i> , . . . 7 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>L. stagnalis</i> , . . . 8 "
-	100	101	-	103	104	-	-	107	108	109	-	-	-	<i>L. palustris</i> , . . . 13 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>L. truncatula</i> , . . . 25 "
99	100	101	-	-	104	-	-	-	108	-	-	-	-	<i>L. glabra</i> , . . . 1 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Ancylus fluviatilis</i> , . . . 23 "
-	-	-	-	-	-	-	-	-	-	109	-	-	-	<i>A. lacustris</i> , . . . 7 "
-	-	-	-	-	-	-	106	-	-	-	-	112	-	<i>Sphærium corneum</i> , . . . 14 "
99	-	101	-	-	-	-	-	-	-	-	-	-	-	<i>S. lacustre</i> , . . . 4 "
-	-	-	-	-	-	-	106	-	108	109	-	-	-	<i>Pisidium amnicum</i> , . . . 4 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>P. fontinale</i> , . . . 16 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>P. pulchellum</i> , . . . 7 "
-	-	101	-	-	-	-	-	-	-	-	-	-	-	<i>P. cinereum</i> , . . . 2 "
-	-	-	-	-	-	105	106	107	108	109	-	-	-	<i>P. pusillum</i> , . . . 18 "
-	-	-	-	-	-	-	-	-	-	-	-	112	-	<i>P. nitidum</i> , . . . 9 "
-	-	-	-	-	-	-	106	-	-	-	111	-	-	<i>P. roscum</i> , . . . 10 "
-	-	-	-	-	-	-	-	-	108	-	-	-	-	<i>Unio margaritifera</i> , . . . 9 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Anodonta cygnea</i> , . . . 5 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>A. anatina</i> , . . . 2 "
-	-	-	-	-	-	-	-	-	-	-	-	-	-	<i>Dreissena polymorpha</i> , . . . 3 "
23	54	35	7	20	11	19	22	39	29	34	15	10	8	= 1335

JOURNAL OF PROCEEDINGS.

SESSION CXVIII.

Wednesday, 21st November 1888.—Dr G. SIMS WOODHEAD, F.R.C.P.E.,
Vice-President, in the Chair.

The following communications were read :

1. "On the Structure of *Pterichthys* and its Allies." By Dr R. H. TRAQUAIR, F.R.S.
 2. "On *Homosteus*, Asmuss (Hugh Miller's *Asterolepis* of Stromness)." By Dr R. H. TRAQUAIR, F.R.S.
 3. "The Seal in Fresh Water." By J. A. HARVIE-BROWN, Esq.
 4. Mr GEORGE BROOK, F.L.S., exhibited a Specimen of the Roller (*Coracias garrula*) shot at Lochbuie, Mull, on 8th September 1888.
 5. Dr TRAQUAIR exhibited a Skeleton of the Great Auk (*Alca impennis*), recently added to the Natural History Department of the Museum of Science and Art.
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Wednesday, 19th December 1888.—Professor Sir WILLIAM TURNER, LL.D.,
F.R.S., in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society :
W. Eagle Clarke, Esq., F.L.S. ; P. D. Coghill, Esq. ; Alfred Hutchinson, Esq., B.Sc. (London) ; George Porter, Esq. ; Philip J. White, Esq., M.B., C.M.

Reports were submitted by the Secretary, the Treasurer, and the Librarian.

The following Office-Bearers were elected :

President—RAMSAY H. TRAQUAIR, M.D., F.R.S.

Vice-Presidents—Professor JAMES GEIKIE, LL.D., F.R.S. ; G. SIMS WOODHEAD, M.D., F.R.S.E. ; GEORGE BROOK, F.L.S., F.R.S.E.

Secretary—WILLIAM EVANS, F.R.S.E.

Assistant-Secretary—JOHN GUNN, F.R.S.G.S.

Treasurer—GEORGE LISLE, C.A., F.F.A.

Librarian—WILLIAM RUSSELL, M.D., F.R.C.P.E.

Councillors—Johnson Symington, M.D., F.R.S.E. ; John Falconer King, F.C.S. ; J. A. Harvie-Brown, F.R.S.E. ; G. Lovell Gulland, M.A., M.B. ; R. Kidston, F.R.S.E., F.G.S. ; T. B. Sprague, M.A., F.R.S.E. ; T. Wemyss Fulton, M.B., C.M. ; J. Gibson, Ph.D., F.R.S.E. ; David Hepburn, M.B. ; A. B. Herbert ; Rev. A. B. Morris ; Professor Sir William Turner, LL.D., F.R.S.

The following communications were read :

1. "Remarks on the present Position of the Society, and the Work of the past Session." By Professor Sir WILLIAM TURNER, LL.D., F.R.S.
2. "On the Occurrence of Sowerby's Whale (*Mesoplodon Sowerbyi*) in the Firth of Forth." By Professor Sir WILLIAM TURNER, LL.D., F.R.S.
3. "On some new Resins from Coals." By W. IVISON MACADAM, Esq., F.R.S.E.
4. "A Theory of the Parasitic Instinct of the Cuckoo." By J. ARTHUR THOMSON, Esq., F.R.S.E.
5. Professor Sir WILLIAM TURNER exhibited, with Remarks, a Specimen showing a Moustache in a young *Delphinus albirostris*.
6. Mr GUNN, on behalf of Mr STUMP, exhibited, with Remarks, Photographs of a Travelled Boulder dug up near Owens College, Manchester.
7. Mr GUNN exhibited a series of Photographs taken by Mr PHILIP SEWELL during his late Expedition to the Kara Sea.

Wednesday, 16th January 1889.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society :
P. STEVENSON, Esq., 23 Royal Park Terrace.

The following communications were read :

1. "On the Skull of an aged Male *Hyperoodon rostratus* found in Shetland." By Professor Sir WILLIAM TURNER, LL.D., F.R.S.
2. "On a new Species of *Dipterus*, with Remarks on the Affinities of the Family Dipterida." By R. H. TRAQUAIR, Esq., M.D., F.R.S.
3. "Photo-Micrographic Apparatus and its Use." By P. D. COGHILL, Esq.
4. "Note on a Tract of modified Epithelium in the Embryo of *Sepia*." By W. E. HOYLE, Esq., M.A., F.R.S.E.

Thursday, 24th February 1889.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society :
Robert C. Munn, Esq., C.A. ; W. Lewis Martin, Esq., M.A. ; Thomas Scott, Esq., C. Carrington & Partners, Esq., M.R.C.M.

The following communications were read :

1. "Notes on several new or rare British Crustacea, etc., from the Firth of Forth," with Enumeration of Specimens. By THOMAS SCOTT, Esq., Chairman, read by the SECRETARY.
2. "Notes on the new Sand-Grass *Strophes peruvianus* in Scotland during the winter and backward movement of the Species." Specimens exhibited. By WILLIAM FANN, Esq., F.R.S.E.
3. "The Cause and Nature of a Series of Temperature Observations on the Thurso River." By WILLIAM FANN, Esq., F.R.S.E.
4. "A new and extinct a Species of the Bone-Fish (*Cypripes aperi*, L.), occurring near the Firth of Forth in August last.
5. "A new and extinct a Species of the Bone-Fish (*Falco osseus*, L.), occurring near the Firth of Forth in August last.

Wednesday, 20th March 1889.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentleman was elected an Ordinary Fellow: Professor C. Drieberg.

The following communications were read:

1. "Notes on a Collection of Birds and Eggs from Paraguay." By J. J. DALGLEISH, Esq., M.B.O.U.
2. "Additional Notes on the Carboniferous Lycopods." By ROBERT KIDSTON, Esq., F.R.S.E., F.G.S.
3. "Note on Variation of Plumage in the Common Rook," with Exhibition of Specimens. By Professor DUNS, D.D., F.R.S.E.
4. "On some Wasps' Nests from South America." Specimens exhibited. By Professor DUNS, D.D., F.R.S.E.
5. "A Revised List of British Echinoidea." By W. E. HOYLE, Esq., M.A., F.R.S.E.
6. "On the Occurrence of the following Molluscs in the Firth of Forth, viz., *Clione borealis*, Brug., and *Stilifer turtoni*, Brod.," with Exhibition of Specimens. By THOMAS SCOTT, Esq.
7. Mr KIDSTON exhibited, with Remarks, fruiting Specimens of *Sphenophyllum cuneifolium*, Sternb. sp.
8. Mr EVANS exhibited a Specimen of the Lesser Shrew (*Sorex minutus*, L.) captured at Cramond on 14th ult.

Wednesday, 17th April 1889.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: J. G. Goodchild, Esq., F.Z.S., M.B.O.U.; J. Berry Haycraft, Esq., M.D., D.Sc., F.R.S.E., Edinburgh University.

Messrs T. B. Sprague and R. C. Millar were appointed auditors of the current session's accounts.

The following communications were read:

1. "Notes on some of the Modes of Formation of Coal." By J. G. GOODCHILD, Esq.
2. "Contribution to the Anatomy of *Pachydriilus*." By FRANK E. BEDDARD, Esq., M.A. Oxon.
3. "The Ancient Lakes of Edinburgh." By JAMES BENNIE, Esq., and THOMAS SCOTT, Esq.

SESSION CXIX.

Wednesday, 20th November 1889.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: A. B. Urmston, Esq.; John Mackie, Esq.

An Opening Address was delivered by Professor JAMES GEIKIE, F.R.S., retiring Vice-President, on "Geological Climates."

The SECRETARY exhibited :

1. A Spoonbill (*Platalea leucorodia*, L.), juv. ♂, killed in Westray, Orkney, on the 10th ult.; and
2. A ♂ hybrid between the Wild Duck (*Anas boschas*, L.) and the Pintail (*Anas acuta*, L.), shot at Newton Hall, near Gifford, East Lothian, on 7th inst.

Wednesday, 18th December 1889.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society : William Black, Esq., S.S.C.; R. C. Elsworth, Esq., M.B., C.M.; James Musgrove, Esq., M.D.; James Tweedy, Esq.; Fortescue Fox, Esq., M.D. Lond.

Reports by the Council, the Library Committee, and the Treasurer for the past Session, were submitted.

The following Office-Bearers were elected :

President—RAMSAY H. TRAQUAIR, M.D., F.R.S.

Vice-Presidents—G. SIMS WOODHEAD, M.D., F.R.S.E.; GEORGE BROOK, F.L.S., F.R.S.E.; JOHNSON SYMINGTON, M.D., F.R.S.E.

Secretary—WILLIAM EVANS, F.R.S.E.

Assistant-Secretary—JOHN GUNN, F.R.S.G.S.

Treasurer—GEORGE LISLE, C.A., F.F.A.

Librarian—J. ARTHUR THOMSON, M.A., F.R.S.E.

Councillors—R. Kidston, F.R.S.E., F.G.S.; T. B. Sprague, M.A., F.R.S.E.; T. Wemyss Fulton, M.B., C.M.; J. Gibson, Ph.D., F.R.S.E.; David Hepburn, M.B.; A. B. Herbert; Rev. A. B. Morris; Professor Sir William Turner, LL.D., F.R.S.; W. Eagle Clarke, F.L.S.; Professor James Geikie, LL.D., F.R.S.; Robert C. Millar, C.A.; William Russell, M.D., F.R.C.P.E.

The following communications were read :

1. "Notes on Crested Birds of Prey." By J. G. GOODCHILD, Esq., F.Z.S., M.B.O.U.
2. "On the Fossils found at Achanarass Quarry, Caithness." By Dr R. H. TRAQUAIR, F.R.S.
3. "On the Structure of *Coccosteus*." By Dr R. H. TRAQUAIR, F.R.S.
4. "On Aquatic Earthworms." By FRANK E. BEDDARD, Esq., M.A., F.Z.S.
5. "The Reproduction of Bees: Suggestions towards the Solution of an old Problem." By J. ARTHUR THOMSON, Esq., M.A., F.R.S.E.

Wednesday, 15th January 1890.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society : Robert W. Felkin, Esq., M.D., F.R.S.E.; John J. Rogerson, Esq., M.A.

The following communications were read :

1. "On an Exhalation of Gases under singular circumstances from a Bog near Strathpeffer." By HUGH MILLER, Esq., F.R.S.E.
2. "On *Phlyctenius*, a new genus of Coccostean Fishes." By R. H. TRAQUAIR, Esq., M.D., F.R.S.

3. "Notes upon certain Marine Accumulations in Largo Bay, Fife, and Portrush, County Antrim." By ALFRED BELL, Esq. Communicated by JAMES BENNIE, Esq.
 4. Mr THOMAS SCOTT, F.L.S., exhibited a small Collection of *Ostracoda* from Lochs and Ponds in the Edinburgh District.
 5. Mr WM. EVANS exhibited a Specimen of the Bank Vole (*Arvicola glareolus*) captured at Cramond in March 1889.
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Wednesday, 19th February 1890.—GEORGE BROOK, Esq., F.L.S., one of the Vice-Presidents, in the Chair.

The following gentlemen were elected Ordinary Fellows of the Society: Frank Gascoigne Bainbridge, Esq.; Professor Saxton, M.R.C.V.S.; William Wilson, Esq., M.A.

The following communications were read:

1. "The Geographical Distribution of Earthworms." By FRANK E. BEDDARD, Esq., M.A., F.R.S.E.
 2. "The Viscera of a Female Chimpanzee." By Dr JOHNSON SYMINGTON, F.R.S.E.
 3. "The Wing-Coverts of Birds in relation to Classification." Part I. By J. G. GOODCHILD, Esq., F.Z.S., M.B.O.U.
 4. "Report on Scottish Land and Fresh-Water Mollusca." By W. DENISON ROEBUCK, Esq., F.L.S. Communicated by the SECRETARY.
 5. Mr BROOK exhibited a Grey Phalarope (*Phalaropus fulicarius*), and a Little Auk (*Mergulus alle*), obtained last month at Lochbuie, Mull.
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Wednesday, 19th March 1890.—Dr R. H. TRAQUAIR, F.R.S., President, in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society: R. C. Mossman, Esq., F.R. Met. Soc.

The following communications were read:

1. "The Classification of Earthworms." By FRANK E. BEDDARD, Esq., M.A., F.R.S.E.
 2. "On the British Species of *Pterichthyidæ*." By Dr R. H. TRAQUAIR, F.R.S.
 3. "On the Occurrence of the Anchovy (*Engraulis encrasicolus*) in Scottish Waters." By Professor J. COSSAR EWART, M.D., F.R.S.E.
 4. "On the British Rats." Specimens of *Mus alexandrinus* (from the "Devastation" at Queensferry), *M. rattus*, *M. decumanus*, and *M. hibernicus*, exhibited. By W. EAGLE CLARKE, Esq., F.L.S.
 5. "The Wing-Coverts of Birds in relation to Classification." Part II. By J. G. GOODCHILD, Esq., F.Z.S., M.B.O.U.
 6. Dr TRAQUAIR exhibited a Specimen of the Bergylt (*Sebastes norvegicus*), caught outside the May Island last August.
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Wednesday, 16th April 1890.—Rev. A. B. MORRIS in the Chair.

The following gentleman was elected an Ordinary Fellow of the Society :
John D. Williams, Esq., M.B., C.M.

Messrs T. B. Sprague and R. C. Millar were appointed auditors of the current session's accounts.

The following communications were read :

1. "Notes on the Palæozoic Species mentioned in Lindley and Hutton's 'Fossil Flora.'" By ROBERT KIDSTON, Esq., F.R.S.E.
 2. "The Wing-Coverts of Birds in relation to Classification." Part III. By J. G. GOODCHILD, Esq., F.Z.S., M.B.O.U.
 3. "Preliminary Notes on a post-Tertiary Fresh-Water Deposit at Kirkland, Leven, and at Elie." With exhibition of Molluscan, Entomostracan, and other Remains. By THOMAS SCOTT, Esq., F.L.S.
 4. "Results of Observations made to determine the Period occupied by different Birds in the Incubation of their Eggs." By WILLIAM EVANS, Esq., F.R.S.E. [Incorporated in paper to the *Ibis* for January 1891.]
 5. "Note on a Recent Exposure of a 'Washout' of Strata in New Redhall Quarry." Photographs shown. By JAMES BENNIE, Esq.
 6. "On the Decomposition of Solutions of Sulphates by Carbonaceous Matter." By W. IVison MACADAM, Esq., F.R.S.E.
 7. "Note on *Pericada indica* living in Hothouses, Kirkcudbrightshire." With Exhibition of Specimens. By ROBERT SERVICE, Esq.
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LIST OF SOCIETIES WHICH RECEIVE THE SOCIETY'S "PROCEEDINGS."

*Those Institutions from which Publications have been received in return are
indicated by an asterisk.*

ENGLAND.

BIRMINGHAM, .	. *	Philosophical Society, King Edward's Grammar School.
Do. .	. *	Natural History Society, Sir Josiah Mason's College.
CAMBRIDGE, .	. *	Philosophical Society.
Do. .	. *	University Library.
CIRENCESTER, .	. *	Editor of the <i>Agricultural Students' Gazette</i> .
DURHAM, .	. *	University Library.
HALIFAX, .	. *	Yorkshire Geological and Polytechnic Society.
LEEDS, .	. *	The Conchological Society of Great Britain and Ireland.
LIVERPOOL, .	. *	Biological Society, University College.
Do. .	. *	Literary and Philosophical Society.
Do. .	. *	Engineering Society, Royal Institution.
LONDON, .	. *	British Museum Library.
Do. .	. *	British (Natural History) Museum, South Kensington.
Do. .	. *	Royal Society, Burlington House, Piccadilly, W.
Do. .	. *	Chemical Society, Burlington House, Piccadilly, W.
Do. .	. *	Geological Society, Burlington House, Piccadilly, W.
Do. .	. *	Linnean Society, Burlington House, Piccadilly, W.
Do. .	. *	Royal Microscopical Society, King's College.
Do. .	. *	Museum of Economic Geology, Jermyn Street.
Do. .	. *	Editor of <i>Nature</i> , 29 Bedford Street, Covent Garden.
Do. .	. *	Editor of <i>Scientific News</i> , 188 Fleet Street, E.C.
Do. .	. *	Zoological Society, Hanover Square.
Do. .	. *	Geologists' Association, University College, W.C.
MANCHESTER, .	. *	Geological Society, 36 George Street.
Do. .	. *	Literary and Philosophical Society, 36 George Street.
Do. .	. *	The Owens College.
NORWICH, .	. *	Norfolk and Norwich Naturalists' Society, The Museum.
OXFORD, .	. *	Bodleian Library.
TRURO, .	. *	Royal Institution of Cornwall.
WATFORD, .	. *	Hertfordshire Natural History Society and Field Club.

SCOTLAND.

ABERDEEN, .	. *	University Library.
COCKBURNSPATH, .	. *	Berwickshire Naturalists' Field Club, Old Cambus.
EDINBURGH, .	. *	Advocates' Library.
Do. .	. *	University Library.
Do. .	. *	Royal Society.

EDINBURGH	Royal Medical Society.
Do	*Royal Scottish Society of Arts.
Do	*Royal Scottish Geographical Society.
Do	*Rotational Society.
Do	*Highland and Agricultural Society.
Do	*Zoological Society.
GLASGOW	*Philosophical Society.
Do	*Natural History Society.
Do	*Zoological Society.
Do	University Library.
PERTH	Perthshire Society of Natural History.
ST ANDREW	University Library.

IRELAND.

DUBLIN	Natural History and Philosophical Society.
DUBLIN	*Royal Irish Academy.
Do	*Royal Medical Society.
Do	*Royal Geological Society of Ireland.

HOLLAND.

AMSTERDAM	*De Koninklijke Akademie van Wetenschappen.
LEYDEN	*Museum van Natuurlijke Historie.
UTRECHT	*Provinciale Genootschap aan Kunsten en Wetenschappen.

SWITZERLAND.

BASEL	*Die Naturforschende Gesellschaft.
BERN	*Allgemeine Schweizerische Gesellschaft für die gesammten Naturwissenschaften.
Do	*Die Naturforschende Gesellschaft.
GENEVA	*Société de Physique et d'Histoire Naturelle.
NEUCHÂTEL	*Société des Sciences Naturelles.
ZÜRICH	*Die Naturforschende Gesellschaft.

GERMANY.

BERLIN	*Königliche Akademie der Wissenschaften.
Do	*Deutsche Geologische Gesellschaft.
Do	*Gesellschaft Naturforschender Freunde.
BOXX	*Naturhistorischer Verein der preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück.
BREMEN	*Verein für Naturwissenschaft.
BRESLAU	*Schlesische Gesellschaft für Vaterländische Cultur.
BRUNSWICK	*Naturwissenschaftlicher Verein.
DRESDEN	*Königliche Sammlungen für Kunst und Wissenschaft.
Do	*Der Verein für Erdkunde.
ELBERFELD	*Naturwissenschaftlicher Verein.
ERLANGEN	University Library.
FRANKFORT-ON-MAIN	*Senckenbergische Naturforschende Gesellschaft.
Do	*Deutsche Malakozoologische Gesellschaft, Dr Kobelt, Schwanheim.
FRIBURG, i. B.	Die Naturforschende Gesellschaft.
GÖTTINGEN	*Königliche Gesellschaft der Wissenschaften.
HALLE	*Kaiserliche Akademie der Naturforscher.

JENA, . . .	*Medicinisch-naturwissenschaftliche Gesellschaft.
LEIPZIG, . . .	*Königliche Sächsische Gesellschaft der Wissenschaften.
Do.	Naturforschende Gesellschaft.
Do.	Editor of the <i>Zoologischer Anzeiger</i> .
MUNICH, . . .	*Königliche Baierische Akademie der Wissenschaften.
STUTTGART, . .	*Verein für Vaterländische Cultur in Württemberg.
WÜRZBURG, . .	*Physikalisch-medicinische Gesellschaft.

AUSTRIA.

AGRAM, . . .	*Societas Croatica Historico-naturalis.
HERMANNSTADT, .	*Siebenbürgischer Verein für Naturwissenschaft.
PRAGUE, . . .	Königliche-böhmische Gesellschaft der Wissenschaften.
TRIESTE, . . .	Società Adriatica di Scienze Naturali.
VIENNA, . . .	*K.k. zoologisch-botanische Gesellschaft.
Do.	*K.k. Naturhistorisches Hof-Museum.

ITALY.

BOLOGNA, . . .	*Accademia delle Scienze dell' Istituto.
MILAN,	*Reale Istituto Lombardo di Scienze, Lettere ed Arti.
Do.	Società Italiana di Scienze Naturali.
MODENA, . . .	Società dei Naturalisti.
NAPLES, . . .	Editor of the <i>Zoologischer Jahresbericht</i> , Zoological Station.
PADUA,	{ *Società Veneto-Trantina di Scienze Naturali residente in Padova.
ROME,	*Reale Accademia dei Lincei.
TRIESTE, . . .	Società Adriatica di Scienze Naturali.
TURIN,	*Reale Accademia delle Scienze.

SPAIN.

MADRID, . . .	*Real Academia de Ciencias exactas, físicas e naturales.
Do.	Sociedad española de Historia natural.

PORTUGAL.

COIMBRA, . . .	Bibliothèque de l'Université.
LISBON, . . .	*Academia Real das Sciencias.

FRANCE.

BORDEAUX, . . .	La Société Linnéenne.
CAEN,	Société Linnéenne de Normandie.
CHERBOURG, . .	*Société Nationale des Sciences Naturelles.
PARIS,	*Académie des Sciences de l'Institut.
Do.	*Société Géologique de France, Rue des grands Augustins, 7.
Do.	*Société Zoologique de France, Rue des grands Augustins, 7.
Do.	Société de Biologie.
Do.	École des Mines.

BELGIUM.

BRUSSELS, . . .	{ *Académie Royale des Sciences, des Lettres, et des beaux Arts.
Do.	*Société Royale Malacologique de Belgique.
Do.	*Société Belge de Microscopie.

SCANDINAVIA.

BERGEN, . . .	*The Museum.
CHRISTIANIA, . . .	*Den Naturhistoriske Forening.
Do.	Universitets Bibliothek.
COPENHAGEN, . . .	*Kongelige Danske Videnskabernes Selskab.
Do.	*Naturhistoriske Forening.
STOCKHOLM, . . .	*Kongliga Svenska Vetenskaps-Akademie.
UPSALA,	*Kongliga Vetenskaps-Societeten.
Do.	*Observatoire Meteorologique.

RUSSIA.

DORPAT,	*Naturforscher Gesellschaft.
KIEV,	*Natural History Society.
MOSCOW,	*Société Imperiale des Naturalistes.
ST PETERSBURG, . . .	*Académie Imperiale des Sciences.
Do.	*Imperial Botanic Garden.

AMERICA.

UNITED STATES.

ALBANY, N.Y., . . .	*New York State Library.
BALTIMORE,	*Johns-Hopkins University Library.
BOSTON,	*American Academy of Arts and Sciences.
Do.	*Society of Natural History.
BROOKVILLE, IND., .	*Brookville Society of Natural History.
CAMBRIDGE, MASS., .	*Harvard University Library.
Do.	*Museum of Comparative Zoology.
CHICAGO,	*Academy of Sciences.
CINCINNATI,	*Society of Natural History.
NEWHAVEN, CONN., .	*Connecticut Academy of Arts and Sciences.
Do.	Yale College Library.
NEW YORK,	*New York Academy of Sciences.
OHIO,	*Mechanics Institute.
PHILADELPHIA, . . .	*Academy of Natural Sciences.
Do.	*Wagner Free Institute.
SAN FRANCISCO, . . .	*California Academy of Sciences.
ST LOUIS,	*Academy of Sciences.
WASHINGTON, . . .	*Smithsonian Institute.
Do.	Philosophical Society.
Do.	*United States National Museum.
Do.	*United States Geological Survey.
Do.	United States Commissioner of Fish and Fisheries.

MEXICO.

MEXICO,	{ *Ministerio de Fomento de la Republica, Osservatorio Meteorologico.
Do.	{ *Sociedad Cientifica, "Antonio Alzate," Osservatorio Meteorologico Central.

CANADA.

HAMILTON,	*The Hamilton Association.
KINGSTON,	*Queen's University.

MANITOBA, . . .	*Historical and Scientific Society, Winnipeg.
MONTREAL, . . .	*The Natural History Society.
OTTAWA, . . .	*Canadian Geological Survey.
Do. . . .	*Royal Society of Canada.
TORONTO, . . .	*The Canadian Institute.

NOVA SCOTIA.

HALIFAX, . . .	*Nova Scotia Institute of Natural Science.
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BRAZIL.

RIO DE JANEIRO, .	Museu Nacional.
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AFRICA.

CAPE TOWN, . . .	South African Philosophical Society.
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ASIA.

BATAVIA, . . .	{ *Koninklijke Natuurkundige Vereeniging in Nederlandsch Indie.
CALCUTTA, . . .	Royal Asiatic Society of Bengal.
SHANGHAI, . . .	*China Branch of the Asiatic Society.
TOKIO, JAPAN, . .	*Imperial University of Japan.

AUSTRALASIA.

ADELAIDE, . . .	*Royal Society of South Australia.
MELBOURNE, . . .	*Royal Society of Victoria.
SYDNEY, . . .	*Royal Society of New South Wales.
Do. . . .	*The Australian Museum.
Do. . . .	*Linnean Society of New South Wales.
WELLINGTON, . .	*New Zealand Institute.

LIST OF FELLOWS,

As at 1st November 1890.

*Those marked * are Life Members.*

Date of
Election.

1856. *Anderson, J., M.D., LL.D., F.R.SS. L. & E., F.L.S., F.Z.S., F.A.S.,
71 Harrington Gardens, London, S.W.
1872. Anderson, James, 135 Mayfield Road.
1880. Anderson, J. M., S.S.C., Strathearn Lodge, 1 Strathearn Place.
1881. Andrew, George, S.S.C., 3 Hope Street.
1888. Ap Iwan, Mihangel, M.B., C.M., Independent College, Bala, N. Wales.
1884. Armitage, J. A., B.A., 15 Waterloo Road South, Wolverhampton
1884. Baidou, Henry Bellyse, B.A., Duncliffe, Murrayfield.
1884. Baily, Edwin, M.B., C.M., Victoria Crescent, Oban.
1890. Bainbridge, Frank Gascoigne, Museum of Science and Art.
1886. Ballantyne, John W., M.D., F.R.C.P., 50 Queen Street.
1885. Barbour, A. H. F., M.A., B.Sc., M.D., 24 Melville Street.
1885. Barrett, W. H., M.B., C.M., 21 Learmonth Terrace.
1886. Barry, J. Houston, 53 George Street.
1884. Beaumont, Alfred, 153 Hither Green Lane, Lewisham, Kent.
1880. *Beddard, Frank E., M.A., Zoological Gardens, London.
1875. Bennie, James, Geological Survey, George IV. Bridge.
1881. *Berry, W., of Tayfield, Newport, Fife.
1880. Bird, George, 24 Queen Street.
1883. Black, Alexander, M.B., M.R.C.P.E., 8 St Vincent Street.
1889. Black, Wm., S.S.C., 38 Hanover Street.
1883. Bowie, A. F., 16 Duncan Street, Newington.
1885. Brook, George, F.L.S., F.R.S.E., The University.
1876. Brown, J. A. Harvie, F.Z.S., F.R.S.E., Dunipace House, Larbert.
1885. Brown, J. Macdonald, M.A., F.R.C.S., Apsley Lodge, Grange.
1860. *Brown, R., M.A., Ph.D., F.L.S., F.R.G.S., Ferslev, Rydal Road,
Streatham, London, S.W.
1876. *Bruce, W. P., Kinelith Mill, Currie.
1882. Bryson, Wm. A., Consulting Electrical Engineer, 5 Bentick Street,
Kelvingrove, Glasgow.
1878. Buchanan, J. H., 4 Doune Terrace.
1885. Buckley, T. E., B.A., F.Z.S., Rossal, Inverness.
1885. Burt, Robert F., 124 Stroud Green Road, Finsbury Park, London, N.
1881. Cadell, H. Moubray, B.Sc., F.R.S.E., of Grange, Bo'ness.

Index of
Members.

1867. Cunningham, W. M., Cunningham, 7 Xavier Road.
1868. Cunningham, Andrew, Burmah Oil Company, Rangoon.
1877. *Cunningham, Sir W. H., Bt., Bart., Castle Craig, Dolphinton.
1874. *Cunningham, W. M., Bt., Bart., Yarrow.
1874. Cunningham, W. M., F.R.S., British Museum, London.
1881. Currie, W. A., F.R.S., St Andrew Square.
1881. Currie, W. M., Junr., Anderson Library.
1887. Currie, E. W., M.B., F.S.C., M.M., Killoan House, Chesterfield.
1888. Currie, W. M., F.R.S., 2 Bonnyrigg Terrace.
1888. Currie, P. M., Royal Veterinary College, Camden Town, London.
1891. Currie, W. M., 11 Great King Street.
1897. *Currie, H. C., F.R.S., 179 High Street, Southampton.
1898. Cooper, J., Havlock House, Shanklin, Isle of Wight.
1898. Currie, P. M., Royal College.
1877. *Dalgleish, J. J., 5 Arthur Crescent.
1885. Denby, Arthur, B.Sc., 10 Deane & Co., 37 Soho Square, London, W.
1887. Denby, George, 38 Great King Street.
1879. Denby, A. N., M.D., State Lunatic Asylum, Austin, Texas, U.S.A.
1882. Dickson, G. W., M.B., M.A., Inverkeithing.
1889. Deleberg, Principal C., Agricultural College, Colombo, Ceylon.
1882. Drummond, W., S.S.C., 4 Leamouth Terrace.
1886. Duncan, James, 5 Albion Place.
1885. Duncan, J. Barker, W.S., 6 Hill Street.
1883. Dunn, Malcolm, Palace Gardens, Dalkeith.
1884. *Dunn, Professor, D.D., F.R.S.E., 14 Greenhill Place.
1883. Edington, Alexander, M.B., C.M., 44 Great King Street.
1863. *Elmonston, A., Heath Bank, Pitlochry.
1889. Elsworth, R. C., M.B., C.M., 10 Lauriston Park.
1880. Erskine, W., Oaklands, Trinity Road.
1880. Evans, Wm., F.F.A., F.R.S.E., 18a Morningside Park, *Secretary*.
1883. Ewart, Professor Cossar, M.D., The University.
1890. Felkin, Robert W., M.D., F.R.S.E., 20 Alva Street.
1884. Fenton, Gerald H., Bellary, Madras, India.
1882. Ferguson, J., 18 Clyde Street.
1884. *Ferguson, James A. E., M.B., Castries, St Lucia, West Indies.
1885. Ferguson, James Haig, M.D., M.R.C.P.E., 25 Rutland Street.
1887. Ferguson, R. M., Ph.D., 12 Moray Place.
1874. Ferguson, William, F.R.S.E., of Kinnundy, Mintlaw.
1889. Fox, Fortescue, M.D., Strathpeffer Spa.
1887. Fulton, T. Wemyss, M.B., C.M., 23 Royal Crescent.
1877. Galletly, A., Museum of Science and Art.
1884. Geikie, Professor, D.C.L., F.R.S., The University.
1883. Gemmill, Wm., M.D., Albert Villa, Beith.
1883. Gibson, E., 1 Eglinton Crescent.
1881. Gibson, J., Ph.D., F.R.S.E., 15 Hartington Gardens.
1880. Glover, J., S.S.C., 1 Hill Street.
1889. Goodchild, J. G., F.Z.S., F.G.S., Museum of Science and Art.
1877. Grieve, S., 159 Dalkeith Road.

Date of
Election.

1886. Grieve, Symington, 1 Burgess Terrace.
1885. Gulland, G. Lovell, M.A., B.Sc., M.D., 6 Randolph Place.
1887. Gunn, John, F.R.S.G.S., The Geographical Institute, Park Road.
1887. Hailes, Dr Clement, Clifton, Bristol.
1883. Hallen, J. H. B., Pebworth, near Stratford-on-Avon.
1883. Hamilton, J. C., Woodside, Champfleurie, Linlithgow.
1881. Hamilton, R., Trinity Lodge, Trinity.
1889. Haycraft, J. Berry, M.D., F.R.S.E., The University.
1883. Henderson, Professor, F.L.S., Christian College, Madras.
1883. Hepburn, David, M.B., The University.
1871. Herbert, A. B., 13 Polwarth Terrace.
1879. Herdman, Professor, F.R.S.E., University College, Liverpool.
1884. Hinxman, Lionel, Geological Survey, George IV. Bridge.
1882. Hogg, A., 94 George Street.
1886. Horn, Wm., Advocate, 20 Belgrave Crescent.
1878. Horne, J., F.G.S., 41 Southside Road, Inverness.
1886. Howden, Robert, M.B., C.M., University of Durham College of Medicine, Newcastle-on-Tyne.
1884. Howell, Henry H., Geological Survey, George IV. Bridge.
1883. Hoyle, W. E., M.A., F.R.S.E., The Owens College, Manchester.
1880. Hunter, James, F.R.C.S.E., F.R.A.S., Craigmillar Villas.
1874. Hunter, John, F.C.S., Minto House, Chambers Street.
1878. *Hunter, J. R. S., LL.D., Daleville, Braidwood, Lanarkshire.
1885. Hunter, Wm., M.B., C.M., St John's College, Cambridge.
1888. Hutchinson, Alfred, B.Sc., Hilda House, Middlesborough.
1850. *Jenner, Charles, F.R.S.E., Easter Duddingston Lodge, Portobello.
1877. Joass, C. Edward, 1 Rankeillor Street.
1880. Johnstone, J. A., Haddington Place.
1886. Kelso, J. E. H., M.B., C.M., High Street, Kincardine-on-Forth.
1881. Kemp, D. W., Ivy Lodge, Trinity.
1869. *Kennedy, Rev. J., M.A., B.D., 36 Gillespie Crescent.
1878. Kidston, Robert, F.G.S., Victoria Place, Stirling.
Kilpatrick, H. G., 104 South Bridge.
1869. King, J. Falconer, F.C.S., Chambers Street.
1880. Laughton, W., Gordon's Mills, near Aberdeen.
1884. Laurie, Malcolm, Nairne Lodge, Duddingston.
1883. Lawson, G. R., Banker, Golspie.
1885. Leith, R. F. C., M.A., M.B., B.Sc., 129 Warrender Park Road.
1879. Leslie, Dr, Falkirk.
1884. Lindsay, R., Curator, Royal Botanic Garden.
1886. Lisle, George, C.A., F.F.A., 5 N. St David Street.
1861. Logan, A., Register House.
1881. Lumsden, J., of Arden, Alexandria, N.B.
1870. Lyon, F. W., M.D., 5 N. Charlotte Street.
1855. *Macadam, Stevenson, Ph.D., Surgeons' Hall.
1885. Macadam, W. Ivison, F.C.S., F.R.S.E., Surgeons' Hall.
1881. Macalpine, A. N., B.Sc., Minto House.
Macconochie, A., Geological Survey, George IV. Bridge.

*Index of
Locations.*

1856. *McCracken*, Professor, Hawthorn Buildings, Kilmarnock.
 1862. **McDonald*, L. M., of Skelton, Skye.
 1863. *Macgregor*, John, L.R.C.P., Roshier, Huddersfield.
 1873. *Mackay*, J. Sutherland, M.A., M.D., 26 Townsend Terrace, Kirkcaldy.
 1855. *MacKenzie*, W. Camer, 6 Harrington Gardens.
 1869. *Mackie*, John, 97 M'Annin Street, Glasgow.
 1874. *MacLachlan*, J., Albert Institute, Dundee.
 1863. *McLaren*, J., Wingate, Co. Dublin.
 1867. *MacMurtrei*, Charles A., M.A., M.D., Oakleigh, Wolverhampton.
 1864. *Macpherson*, Rev. H. A., 21 Cecil Street, Carlisle.
 1862. *McVean*, C. A., C.E., Killisnoe House, Pennyghael, Oban.
 1866. *MacWatt*, R. Charles, M.A., M.B.
 1860. *Marsden*, R. S., D.Sc., Malton, Yorkshire.
 1869. *Martin*, W. Lewis, M.A., 16 Warrender Park Terrace.
 1865. *Meile*, George James McCarthy, Blanche Villa, Pretoria.
 1873. *Millar*, R. K., 13 Lennox Street, Eton Terrace.
 1869. *Miller*, Robert C., C.A., 8 Broughton Place.
 1861. *Miller*, Hugh, F.R.S.E., Geological Survey, George IV. Bridge.
 1853. *Mitchell*, Robert, 14 Marcellan Road.
 1876. *Moffat*, A., 5 Scoone Gardens.
 1864. *Morris*, Rev. A. B., 18 Edlison Street.
 1890. *Mossman*, R. C., F.R.Met.S., 10 Blacket Place.
 1860. *Muirhead*, G., Mains of Haddo, Aberdeen.
 1862. *Murdoch*, J. B., Capelrig, Mearns, Renfrewshire.
 1861. *Murdoch*, T. Barr, M.B., C.M., 31 Morningside Road.
 1874. *Murray*, D. R., M.B., C.M., 41 Albany Street, Leith.
 1877. *Murray*, John, Ph.D., LL.D., F.L.S., F.R.S.E., 28 Douglas Crescent.
 1864. *Murray*, R. Milne, M.A., M.B., 10 Hope Street.
 1869. *Musgrave*, James, M.D., 10 Lauriston Park.
 1860. *Nicholson*, Professor, Aberdeen.
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 1864. *Oliphant*, J. C., M.A., 50 Palmerston Place.
 1867. *Oliver*, John S., 12 Greenhill Park.
 1866. **Panton*, George A., F.R.S.E., 73 Westfield Road, Edgbaston, Birmingham.
 1870. *Peach*, B. N., F.R.S.E., Geological Survey, George IV. Bridge.
 1880. *Pearcey*, F. G., The Owens College, Manchester.
 1888. *Porter*, George, 14 Thirlstane Road.
 1883. *Pullar*, Alfred, M.D., Leonard Bank, Beulah Hill, Upper Norwood, London, S.E.
 1879. *Pullar*, R. D., Ochil, Perth.
 1869. *Purvis*, G. Carrington, M.B., C.M., 13 E. Preston Street.
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 1861. **Ramsay*, Major Wardlaw, Whitehall, Rosehill, Midlothian.
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1883. Robertson, W. W., Wardie Bank.
1890. Rogerson, John J., LL.B., Merchiston Castle.
1880. Rowland, Professor, M.A., M.D., The University, Salem, Oregon, U.S.A.
1887. Russell, William, M.D., F.R.C.P.E., 46 Albany Street.
1890. Saxton, Professor, M.R.C.V.S., Colonial College, Hollesley Bay, Suffolk.
1889. Scott, Thomas, F.L.S., 14 Lorne St., Leith Walk.
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1886. Service, Robert, Laurieknowe, Maxwelltown.
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1883. Sherrieff, George, Woodcraft, Larbert.
1882. Simpson, John, Anatomical Museum, The University.
1869. *Skirving, R. Scot., 29 Drummond Place.
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1889. Stevenson, P., 23 Royal Park Terrace.
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1882. Stirling, J., of Garden, Stirlingshire.
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1882. Swinburne, J., 21 Saumarez Street, St Peter's Port, Guernsey.
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1881. Tanner, S. T., 9 Montague Street, Portman Square, London, W.
1851. Taylor, A., 11 Lutton Place.
1887. Thomson, J. Arthur, F.R.S.E., 30 Royal Circus.
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1859. Traquair, R. H., M.D., F.R.S., Museum of Science and Art.
1885. Turnbull, Percy M., Oakdale, Leytonstone, Essex.
1858. *Turner, Professor Sir Wm., 6 Eton Terrace.
1889. Tweedy, James, Solicitor, 14 Hartington Road, Stockton-on-Tees.
1889. Urmston, A. B., San Pedro, Janos, Canton Galeana, Chihuahua, Mexico.
1882. Wallace, Professor R., The University.
1887. Wallace, Samuel W., The University.
1887. Watson, G. W., L.D.S., 3 Walker Street.
1884. Watson, Wm., M.D., Lockarton, Slateford.
1884. Webster, A. D., M.D., 20 Newington Road.
1887. Webster, Hugh A., F.R.S.E., The University.

INDEX.

- Alca impennis*, Skeleton of, 505.
 Anchovy in Scottish Waters, 333.
 Ancient Lakes of Edinburgh, 126.
 Aquatic Earthworms, 208.
Arvicola glareolus at Cramond, 509.
Asterolepidae, The Structure and Classification of, 23.
Asterolepis, 32.
 Auk, Great, Skeleton of, 505.
 Auk, Little, in Mull, 509.

 Bank Vole at Cramond, 509.
 Beddard, Frank E., 101, 208, 235.
 Bell, Alfred, 290.
 Bennie, James, 126, 290, 334, 392.
 Bergylt near May Island, 509.
 Birds and Eggs from Paraguay, 73.
 Boar-Fish from near May Island, 506.
 Borough Loch, 131.
Bothriolepis, 35.
Bothrodendron, 92.
Bothrodendron Wiikianum, 94.
 British *Echinoidea*, Revised List of, 398.
 Brook, George, 156, 161, 505, 509.

Capros aper from near May Island, 506.
Chartergus nidulans, 71.
 Chimpanzee, The Viscera of a Female, 297.
 Clarke, W. Eagle, 509.
 Climates, Geological, 171.
Clio borealis, in Firth of Forth, 156.
 Coal Seams, Modes of Formation of, 97.
Coccosteus, 47, 211.
Coracias garrula in Mull, 505.
 Crested Birds of Prey, 202.
 Crustacea from the Kirkland Marl, 337.
 Crustacea new to the Firth of Forth, 154.
 Cubital Coverts of *Euornithæ*, 317.
 Cuckoo, Parasitic Habit of the, 60.
Cymbasoma rigidum, 156.

 Dalglish, J. J., 73.
Delphinus (Lagenorhynchus) albirostris, 14.
 Diatoms from Redhall Quarry, 154.
 Distribution of Earthworms, 269.
 Dolphin, The White-Beaked, 14.
 Duns, Professor J., 68, 71.

 Earthworm, Exotic, in Kircudbrightshire, 396.
 Earthworms, Aquatic, 208.
 Earthworms, The Distribution and Classification of, 235.
Echinoidea, British, Revised List of, 398.
Engraulis encrasicolus in Scottish Waters, 333.
 Epithelium, A Tract of Modified, in the Embryo of *Sepia*, 58.
Erythrops goëssii, 155.
Euornithæ, Cubital Coverts of, 317.
 Evans, William, 106, 168, 507, 509, 510.
 Ewart, Professor, 333.

Falco vespertinus near Jedburgh, 168.
 Fins, Vertical, of *Lepadogaster*, Development of, 167.
 Foraminifera from Largo Bay, 293.

 Gases, Exhalation of, from Bog near Strathpeffer, 225.
 Geikie, Professor J., 171.
 Geological Climates, 171.
 Glaciation, 198.
 Glow, Loch, 313.
 Goodchild, J. G., 97, 202, 317.
 Great Auk, Skeleton of, 505.

Heteromysis formosa, 156.
Homosteus, Asmuss, compared with *Coccosteus*, 47.
 Hoyle, W. E., 3, 58, 398.
 Hybrid between Wild Duck and Pintail, 508.
Hyperoodon latifrons, 19.
Hyperoodon rostratus, Skull of an Aged, 19.

- Incubation, Periods of, in Birds, 510.
- Kidston, Robert, 88, 345, 506.
- Kirkland Marl, 334.
- Lakes, Ancient, of Edinburgh, 126.
- Land and Fresh-Water Mollusca, Census of Scottish, 437.
- Largo, Marine Accumulations at, 290.
- Lepadogaster bimaculatus*, 165.
- Lepadogaster Decandolli*, 164.
- Lepadogaster Gouanii*, 163.
- Lepadogaster microcephalus*, 166.
- Lepadogaster*, The British Species of, 161.
- Lepidodendron Veltheimianum*, 89.
- Leptomys gracilis*, 155.
- Lesser Shrew at Cramond, 507.
- Lindley and Hutton's Palæozoic Species, 345.
- Lycopods, Carboniferous, Notes on some British, 88.
- Marine Accumulations in Largo Bay, and at Portrush, 290.
- Mergulus alle* in Mull, 509.
- Microbrachius*, 43.
- Micropteron bidens*, 5.
- Miller, Hugh, 225.
- Mollusca from Ancient Edinburgh Lakes, 139, etc.
- Mollusca from Elie, 339.
- Mollusca from Kirkland Marl, 337.
- Mollusca from Largo Bay, 292.
- Mollusca, Land and Fresh-Water, Census of Scottish, 437.
- Mollusca new to the Firth of Forth, 154.
- Motella*, The Larval Stages of, 156.
- Mus alexandrinus* from the "Devastation," Queensferry, 509.
- Myrapetra*, 72.
- Mysidopsis didelphys*, 155.
- North Loch, 129.
- Ostracoda from Edinburgh District, 139, 293, 313, 339.
- Pachydrilus*, British Species of, 101.
- Palæozoic Species mentioned in Lindley and Hutton's "Fossil Flora," 345.
- Pallas's Sand-Grouse in Scotland, 106.
- Paraguay, A Collection of Birds and Eggs from, 73.
- Perichæta indica* in Kirkcudbrightshire, 396.
- Periods of Incubation in Birds, 510.
- Phalarope, Grey, in Mull, 509.
- Phlyctenaspis*, a New Genus of *Coccoseidae*, 227.
- Platalea leucorodia* in Orkney, 508.
- Portrush, Fossils from, 295.
- Post-Tertiary Fresh-Water Deposits from Kirkland and Elie, 334.
- Presidential Address, 1, 171.
- Pterichthys*, 23.
- Rats, The British, 509.
- Red-footed Falcon near Jedburgh, 168.
- Redhall, New, Quarry, "Washout" at, 392.
- Roebuck, W. Denison, 437.
- Roller in Mull, 505.
- Rook. Variations in the Plumage of, 68.
- Sand-Grouse, *see* Pallas's Sand-Grouse.
- Scott, Thomas, 126, 154, 293, 313, 334.
- Scottish Land and Fresh-Water Mollusca, Census of, 437.
- Sebastes norvegicus* near May Island, 509.
- Sepia*, A Tract of Modified Epithelium in the Embryo of, 58.
- Service, Robert, 396.
- Shrew, Lesser, from Cramond, 507.
- Sigillaria*, 91.
- Sorex minutus* from Cramond, 507.
- Sowerby's Whale in the Firth of Forth, 5.
- Sphenophyllum cuneifolium*, Fruiting Specimens of, 507.
- Spoonbill from Orkney, 508.
- Stilifer tortoni*, in Firth of Forth, 156.
- Symington, Dr, 297.
- Syrnhaptes paradoxus* in Scotland, 106.
- Thomson, J. Arthur, 60, 508.
- Traquair, Dr, 23, 47, 211, 227, 505, 506, 509.
- Turner, Prof. Sir William, 1, 5, 14, 19.
- Vespa nidulans*, 71.
- Viscera of a Female Chimpanzee, 297.
- Vole, Bank, at Cramond, 509.
- "Washout" of Strata in New Redhall Quarry, 392.
- Wasps' Nests from South America, 71.
- Whales, 5, 19.
- Wing-Coverts of Birds, 317.
- Zoological Notes, 101, 208.

(B)

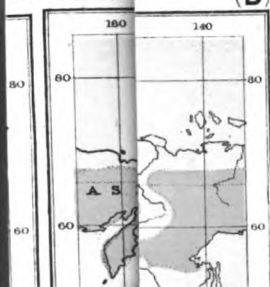


Fig 7.

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Fig. 7.



Fig. 7a.

M'Farlane & Erskine, Printers, Edinburgh.



Fig. 3a.



Fig. 1.



Fig. 2a.



Fig. 4.



Fig. 8.



Fig. 9.



Fig. 6b.



Fig. 6.



Fig. 10.



Fig. 5.

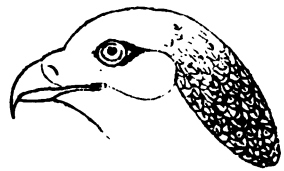


Fig. 6a.



Fig. 7.

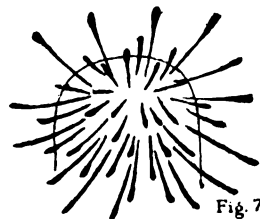


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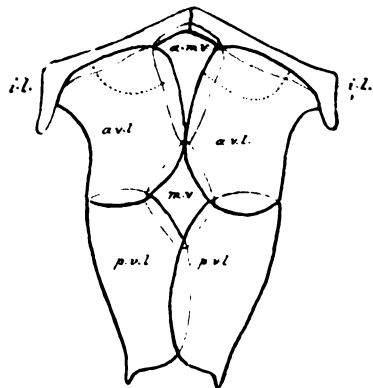
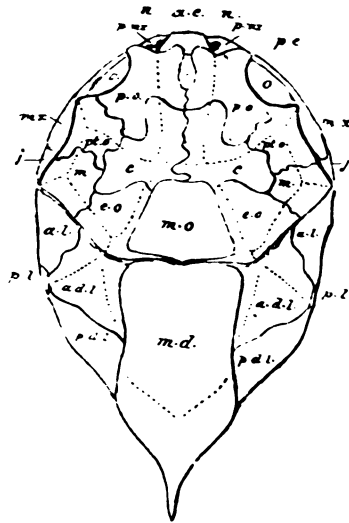
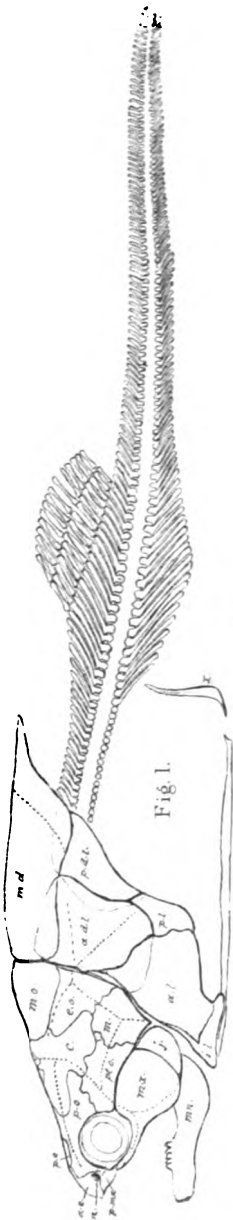




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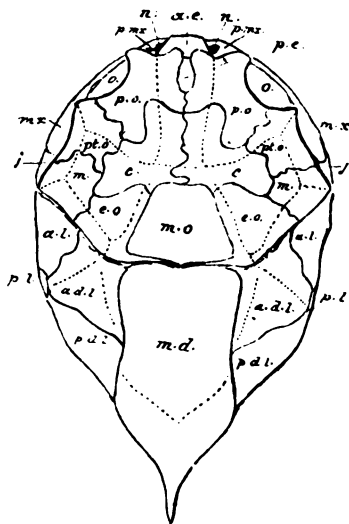


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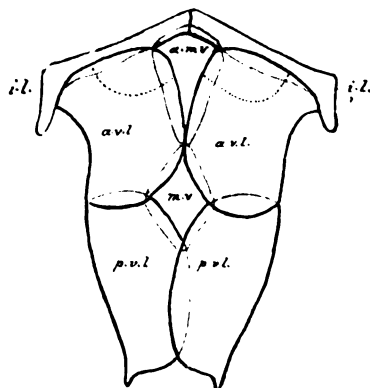


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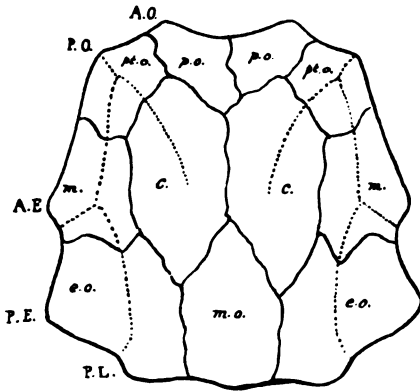


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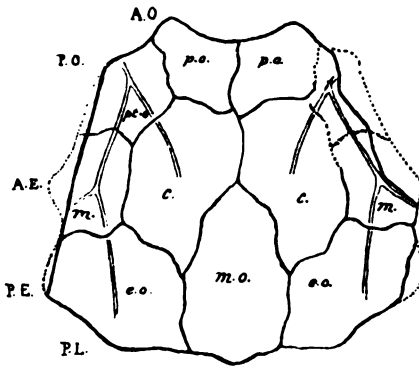


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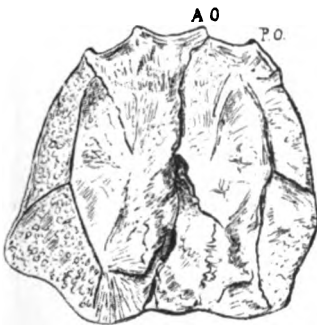


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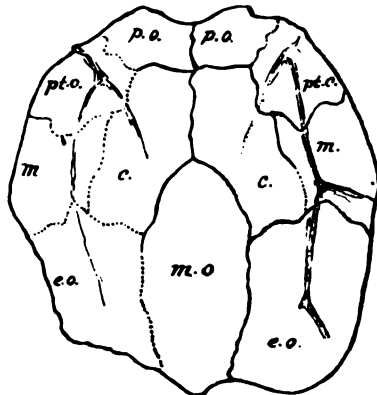
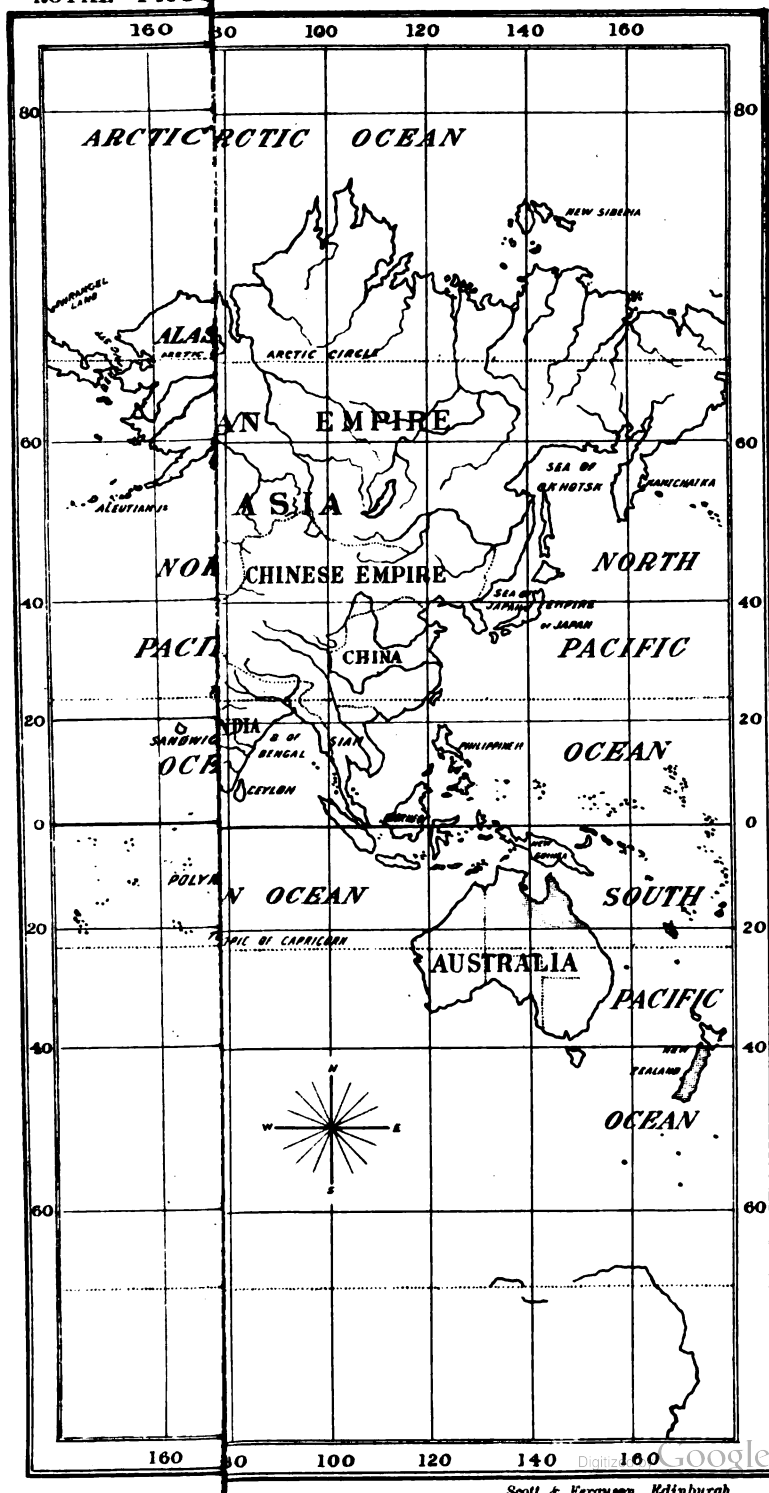
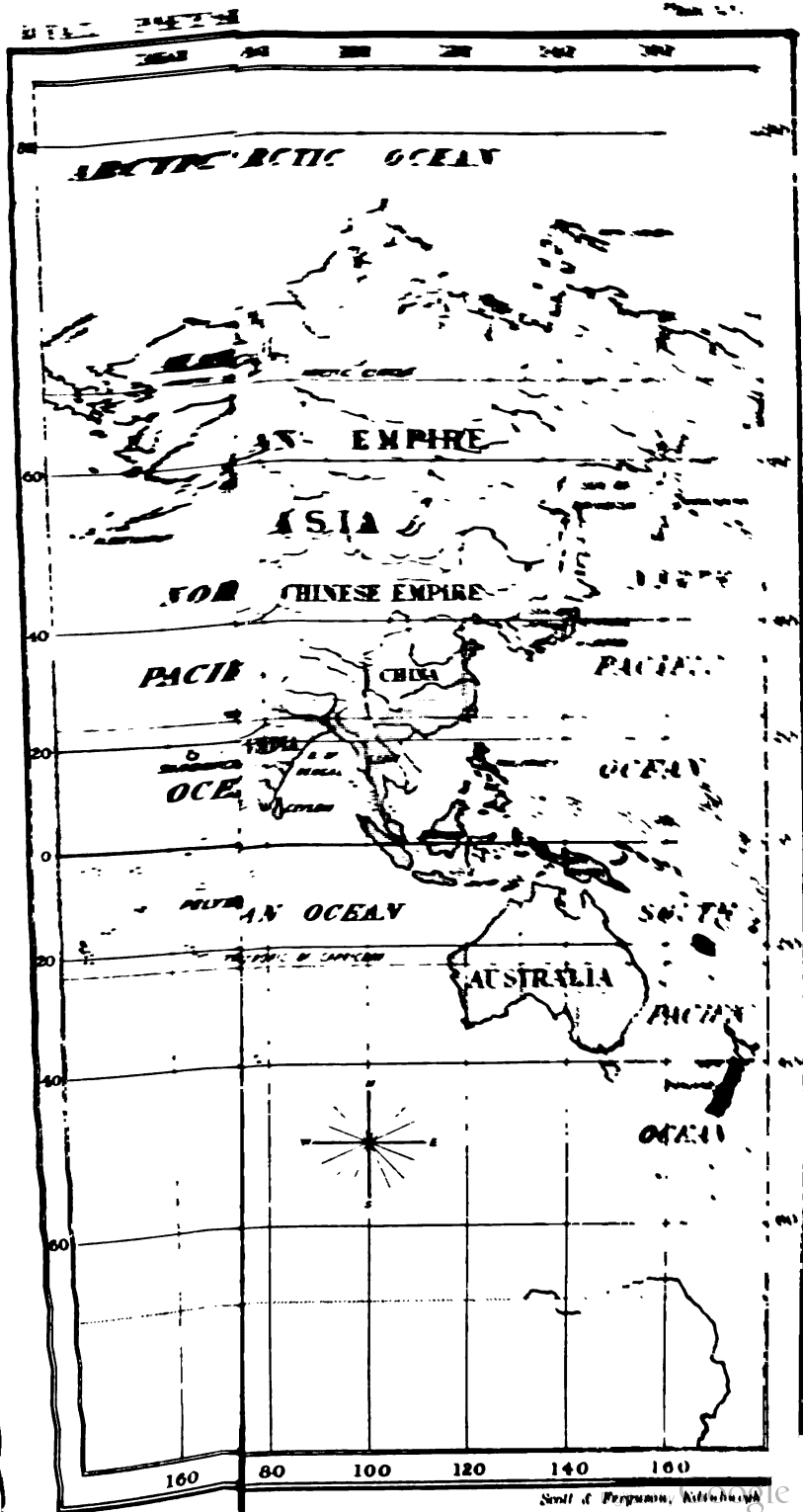
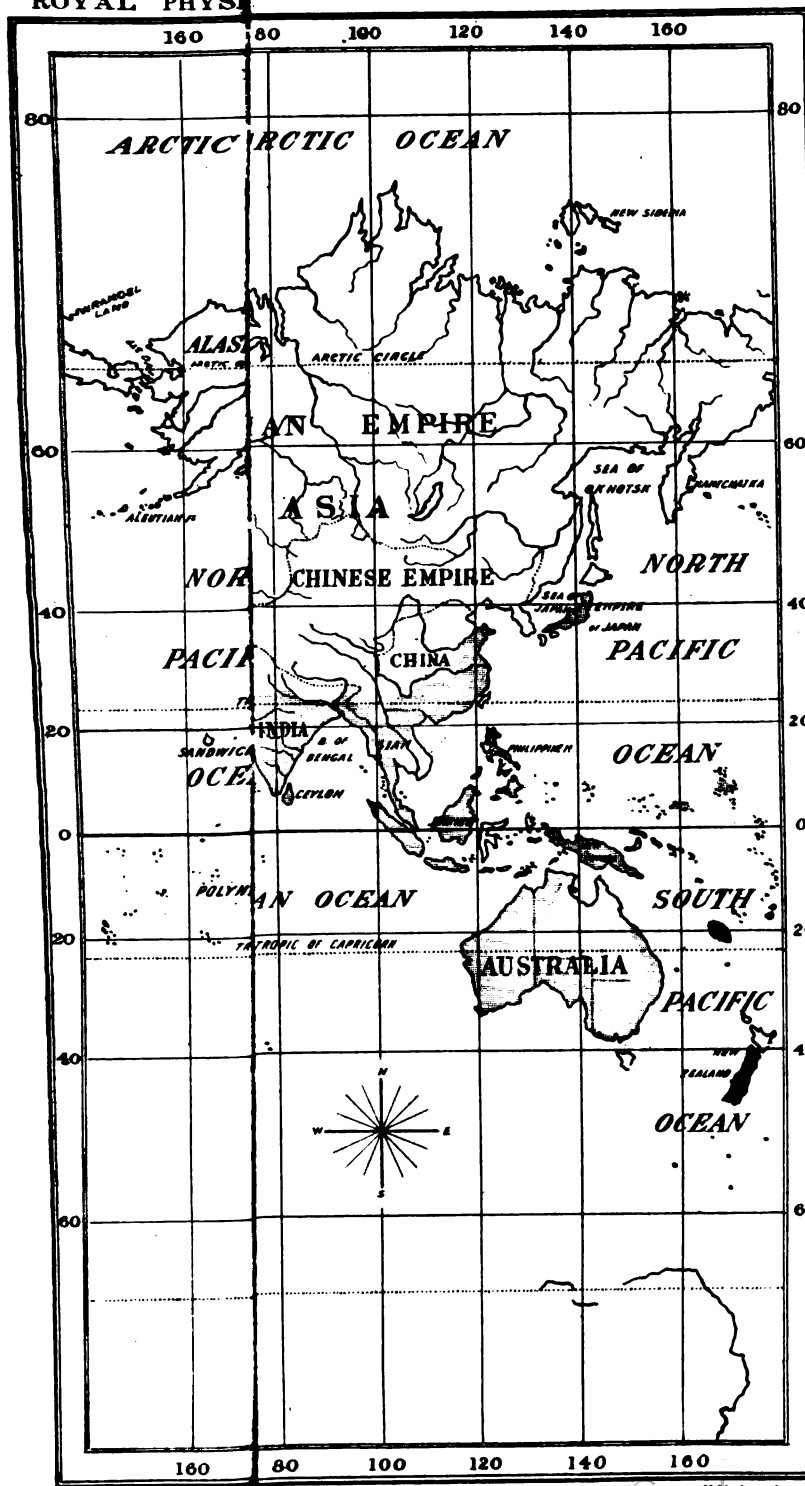


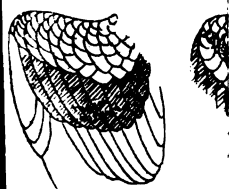
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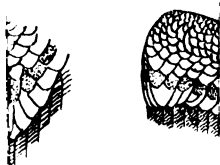


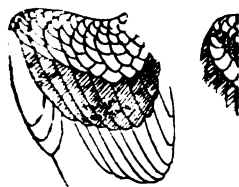


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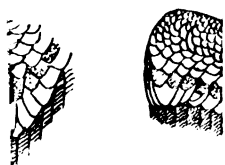




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9



Notes of the Survey

Vol. X.

Upper

Boulder

Clay

Position of
Lower Boulder
Clay

Shale

Sandstone

Upper

Boulder

Clay

Rubbish

of

"Wash-out"

with

Boulders

at

Bottom



W. F. Fiske & E. R. Fiske, Lith. Edm.

R. Lunn. Geol. Survey. Photo.

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